AIR RESOURCES BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

2001 CALIFORNIA $PM_{2.5}$ MONITORING NETWORK DESCRIPTION

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California Environmental Protection Agency
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EXECUTIVE SUMMARY

This is the fourth annual report documenting $PM_{2.5}$ network design and implementation effort in California. The goal of the $PM_{2.5}$ monitoring program in California is to provide ambient data that support the State's air quality programs, including mass measurements and speciation data. Data from this program will be used to identify nonattainment areas, develop and track implementation plans, assess regional haze, assist in health effects studies, and support other ambient aerosol research activities.

This document provides an overview of the $PM_{2.5}$ implementation effort in California to date. It addresses the network expansion proposed for the twelve month period starting July 2001, including the rationale for the various network components. Our progress in implementing the $PM_{2.5}$ monitoring network is summarized in the table below.

Table 1
$PM_{2.5}$ Network Implementation Progress

Network Element	Previously Deployed	Planned through June 2002	Purpose
24-hour Mass	82 sites	0 sites	Comparison with standards.
Continuous Mass	21 sites	15 sites	Public reporting, aerosol research, background monitoring, and transport assessment.
24-hour Speciation	6 sites	11 sites	Characterization of aerosols, development of emission control strategies, and tracking progress of control programs.
Continuous Speciation	0[1] sites	At least 10[2] sites	
Laboratory	8 laboratories	0 laboratories	Weighing mass filters.

This year's network description addresses the current status of the network and plans for expansion in two separate areas of $PM_{2.5}$ monitoring. The State's network of 24-hour mass monitors is fully deployed at this time. The planned areas of expansion include $PM_{2.5}$ continuous mass monitoring and $PM_{2.5}$ speciation monitoring.

While California's $PM_{2.5}$ monitoring network is still expanding, most of the existing sites have been in operation since early 1999 and now have two years of 24-hour Federal Reference Method (FRM) $PM_{2.5}$ mass data. While two years of 24-hour FRM mass data are not sufficient for determining attainment or nonattainment status (three years of data are required for this), the existing data are sufficient

[1] Some continuous speciation monitoring previously occurred as part of special studies that will now be included into the routine $PM_{2.5}$ monitoring network.

[2] More than 10 sites may be deployed if monitors are available. Some sites will have only one chemical-specific continuous speciation monitor, others will have two or more.

for making some comparisons among the sites (refer to Chapter 4, Section A. and Appendix C for a more complete discussion).

The 1999 data and preliminary 2000 data show that the highest 24-hour $PM_{2.5}$ mass concentrations vary widely throughout the State. Table 2 shows the range of highest $PM_{2.5}$ concentrations for sites in California.

Table 2
Range of Highest $PM_{2.5}$ Concentrations for Sites in California
(Based on 1999 Data and Preliminary 2000 Data)

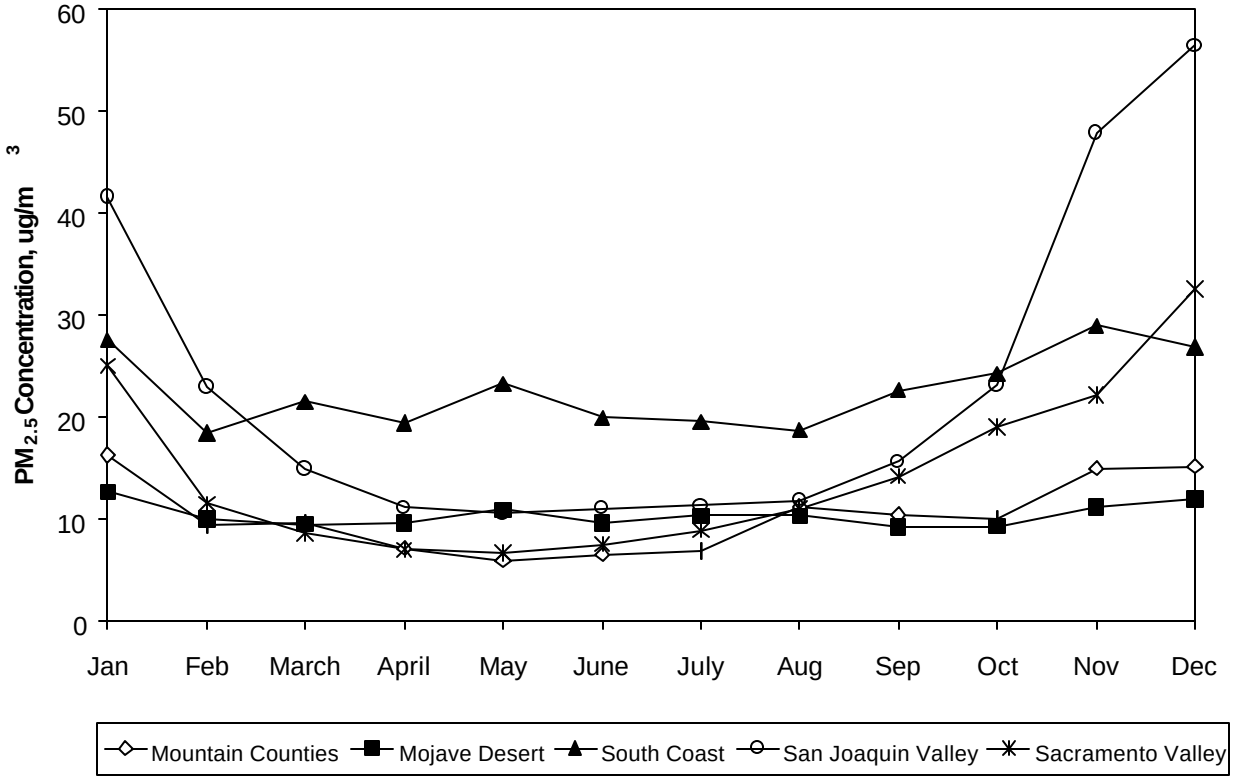
Averaging Time	Lowest High		Highest High	
	Site	Concentration	Site	Concentration
24-hour	Lakeport-Lakeport Boulevard	9.4 $\mu g/m^3$	Fresno-1st Street	160 $\mu g/m^3$
Annual Average	Echo Summit	3.8 $\mu g/m^3$	Bakersfield-5558 California Avenue	31.2 $\mu g/m^3$

In general, both the highest 24-hour and annual average $PM_{2.5}$ concentrations are found at sites in the South Coast Air Basin and San Joaquin Valley Air Basin. However, relatively high 24-hour measurements are also found in the Sacramento Valley Air Basin, the San Francisco Bay Area Air Basin, and certain parts of the Mountain Counties Air Basin. Also, while the annual average concentrations at sites in these areas are substantially lower than are those in the South Coast Air Basin and San Joaquin Valley Air Basin, the annual average concentrations in 1999 at some sites in the Sacramento Valley Air Basin, as well as that for one site in 2000, exceed 15 $\mu g/m^3$, which is the level of the national annual $PM_{2.5}$ standard.

On average, the highest 24-hour concentrations in 1999 and 2000 occurred in November, December, and January, while the lowest concentrations occurred between March and August. Most of the California air basins, as illustrated in Figure 1, follow this seasonal pattern to some degree.

The seasonality is most pronounced in the San Joaquin Valley Air Basin, where the November-December-January concentrations were on the order of four to five times greater than those for March through August. Less pronounced seasonality occurred in the San Francisco Bay Area, San Diego, Sacramento Valley, North Coast, and Mojave Desert Air Basins. In other MPAs, the highest concentrations occurred throughout the year, though in most cases, these "high" values were low, when compared with those MPAs that showed seasonality. The exception is the South Coast Air Basin, where fairly high values occurred throughout the year. As the $PM_{2.5}$ monitoring program continues and more data become available, more refined analyses will be possible, as well as definitive determinations of attainment and nonattainment status.

Figure 1
Monthly Average $PM_{2.5}$ Concentrations by Air Basin



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CHAPTER 1
INTRODUCTION

Particulate matter (PM) has long been a concern for air quality officials because of its adverse impacts on health and visibility. PM is any material, except pure water, that exists in the solid or liquid state in the atmosphere. The size of particulate matter can vary from coarse wind blown dust particles to fine particle combustion products. PM is generally divided into two major categories: PM_{10} and $PM_{2.5}$. PM_{10} comprises particles with an aerodynamic diameter less than or equal to a nominal 10 microns (about 1/7 the diameter of a single human hair). Their small size allows them to make their way to the air sacs deep within the lungs where they may be deposited and result in adverse health effects. PM_{10} also causes visibility reduction. In contrast, $PM_{2.5}$ is a subset of PM_{10} and includes those particles with an aerodynamic diameter less than or equal to a nominal 2.5 microns. $PM_{2.5}$ is primarily a product of combustion. Particles within the $PM_{2.5}$ fraction of PM_{10} penetrate more deeply into the lungs, and cause the majority of the visibility reduction attributable to PM.

On July 18, 1997, the United States Environmental Protection Agency (U.S. EPA) promulgated new National Ambient Air Quality Standards for PM_{10} and $PM_{2.5}$. Although there were existing PM_{10} monitors nationwide in 1997, there was no national $PM_{2.5}$ monitoring network. ARB staff have worked closely with the U.S. EPA to expeditiously deploy $PM_{2.5}$ monitors throughout California. The U.S. EPA regulations require that the states submit an annual $PM_{2.5}$ monitoring network description by July 1. This document fulfills the requirement for 2001.

The American Trucking Association and several other industry groups challenged the standards. In 1999, a three-judge panel of the U.S. Court of Appeals for the District of Columbia returned the standards to the U.S. EPA to provide a better rationale for how it selected the particular levels of the standards. In May 2000, the U.S. Supreme Court granted a request filed by the U.S. EPA and the Department of Justice to review the case. On February 27, 2001, the Supreme Court rejected industry's argument and upheld the federal $PM_{2.5}$ standards.

As a result of the U.S. Supreme Court's ruling, we expect the schedule for implementing the standards to continue as originally envisioned. Three years of $PM_{2.5}$ monitoring data are needed to designate areas as attainment or nonattainment. In addition, when the U.S. EPA promulgated the $PM_{2.5}$ standards, it agreed to complete its next health review of the standards prior to designating areas. That review is scheduled to be finished in 2002. Thus, we expect nonattainment areas will be designated by 2003 at the earliest. $PM_{2.5}$ attainment plans would then be due three years later - 2006 at the earliest. We expect the U.S. EPA will issue guidance detailing the specific planning requirements and timeliness for attaining the $PM_{2.5}$ standards, now that the court case has been resolved.

California is in the process of reviewing the State Ambient Air Quality Standards (State standards). Senate Bill 25 (Chapter 731, Statutes of 1999), signed by Governor Davis on October 7, 1999, requires the Air Resources Board (ARB) to review all existing State standards to determine whether they adequately protect public health, including infants and children, with an adequate margin of safety. State standards found to be inadequate will be revised, based on a priority ranking. The requirements of Senate Bill 25 put a special emphasis on infants and children because they may be more susceptible to the health effects of air pollutants than adults. Reasons for their higher susceptibility include higher relative ventilation rates, narrower airways, developing organs and tissues, and greater exposure because of increased time spent outdoors.

The ARB and the Office of Environmental Health Hazard Assessment (OEHHA) are currently reviewing the state PM_{10} and sulfate standards for their ability to adequately protect public health, including that of infants and children. We expect to bring proposed standards to the Board for consideration in 2002. The U.S. EPA is also reviewing the national PM standards and may recommend revisions in 2002 or 2003.

As California moves forward with its PM monitoring program, data from the $PM_{2.5}$ monitoring program will be used for assessing attainment of the national standards, developing and tracking implementation programs, assessing regional haze, and assisting health effects studies and other ambient aerosol research activities. During 1998, 1999, and 2000, the ARB and local air pollution control districts and air quality management districts (air districts) established a comprehensive network of community-representative $PM_{2.5}$ monitoring sites and developed an infrastructure for the program (ARB, 1998; ARB, 1999; ARB, 2000a). The main network of $PM_{2.5}$ monitoring sites are sometimes referred to as “core” or “Federal Reference Method” (FRM) sites. The FRM sites collect 24-hour mass data using federally approved methods, which means they satisfy specific federal regulatory requirements. These requirements ensure that data from these sites are suitable for comparison with the national $PM_{2.5}$ standards.

California’s $PM_{2.5}$ monitoring network now includes 82 FRM monitoring sites. The 24-hour $PM_{2.5}$ mass samplers at all 82 sites are designated as State and Local Monitoring Stations (SLAMS), and the samplers at 20 of those sites are proposed for designation as National Air Monitoring Stations (NAMS). NAMS sites are part of a federal network meant to measure long-term $PM_{2.5}$ trends, while SLAMS sites (which include the NAMS as a subset) collect data needed for developing an effective State Implementation Plan (SIP). The ARB and air districts proposed in June 2000 to designate the 20 sites as NAMS. The U.S. EPA has not yet taken final action in approving any of these designations.

The monitoring network also includes 21 collocated FRM samplers for quality assurance and quality control purposes; six National Air Monitoring Stations (NAMS) sites for 24-hour $PM_{2.5}$ speciation sampling; 21 sites with continuous

$PM_{2.5}$ mass monitors; and eight fully equipped laboratories for weighing $PM_{2.5}$ FRM filters. The monitoring program also includes a comprehensive quality assurance program.

The ARB had planned to establish an FRM site at North-West Lake Tahoe. Deployment at this site was delayed because of problems in finding a suitable location. Plans for a North-West Lake Tahoe site have now been dropped. The concentrations at the South Lake Tahoe site, which would be expected to be higher than those in the North-West Lake Tahoe area, are far below the levels of the standards. If there is a compelling need for such a $PM_{2.5}$ site in the future, deployment of a monitor can be reconsidered.

In the next 12 months, the ARB and air districts plan to deploy more continuous mass samplers and speciation samplers at sites throughout the network. These include 15 new continuous mass monitors, which will complete California's continuous $PM_{2.5}$ mass monitoring network.

The speciation network will include two components: NAMS and SLAMS. The NAMS speciation sites and instrumentation have been selected in accordance with U.S. EPA directives and are operational except for
Simi Valley-Cochran Street. In contrast to the NAMS, the ARB and air districts have flexibility in choosing the suite of speciation monitoring instruments to use in the SLAMS portion of the speciation network. Over the next twelve months, the ARB and the air districts plan to add filter-based speciation samplers to eleven additional sites and continuous $PM_{2.5}$ speciation samplers to at least ten sites.

The remaining sections of this document describe California's existing and proposed $PM_{2.5}$ monitoring network and related activities. Chapter 2 summarizes the $PM_{2.5}$ elements funded and deployed prior to June 30, 2001, while Chapter 3 describes additions to the network planned during the next twelve months. Chapter 4 outlines $PM_{2.5}$ data analysis, completeness, and distribution. Finally, Chapter 5 describes a number of $PM_{2.5}$-related monitoring efforts taking place here in California. Some of these programs were established to monitor fine particulate matter even before the U.S. EPA promulgated the national $PM_{2.5}$ standards.

In addition to these chapters, there are five appendices. Appendix A provides a table of the $PM_{2.5}$ mass monitoring in California that can be used for regulatory comparisons to the standards, along with operating agency, type of monitor, date of first valid sample, sampling schedule, and supporting lab. Appendix B includes a table of existing and planned $PM_{2.5}$ monitoring sites in California and lists the types of $PM_{2.5}$ samplers operating at each site, including the filter-based and continuous monitors for $PM_{2.5}$ mass and speciation. Appendix C includes a summary of data collected at sites in the $PM_{2.5}$ FRM mass network during 1999 and 2000. Appendix D provides a list of acronyms used in this document. Finally, Appendix E is a glossary that describes the technical terms used in this

document. The ARB staff sought input from the air districts, the U.S. EPA, and the public in preparing this document. The ARB maintains a list of individuals interested in $PM_{2.5}$ monitoring in California. The staff used this list to distribute a draft version of this report for public comments. The draft report was also posted on an ARB web site and distributed by mail and email.

CHAPTER 2

SUMMARY OF $PM_{2.5}$ MONITORING NETWORK THROUGH JUNE 2001

This chapter discusses the status of the $PM_{2.5}$ network as of June 2001. Included are descriptions of the current FRM mass sampler, continuous mass sampler, and speciation sampler networks. Also included are short discussions of currently deployed $PM_{2.5}$-related meteorological, background, and transport monitors. Two appendices are close companions to this chapter: Appendix A describes all sites in the FRM mass sampler network, including each site's operating agency and analysis laboratory, sampling schedule, and first valid sampling date; and Appendix B summarizes all existing and planned $PM_{2.5}$ monitoring in California.

A. Federal Reference Method (FRM) Mass Samplers

The primary objective of the $PM_{2.5}$ mass monitoring program is to identify areas where $PM_{2.5}$ concentrations exceed one or both of the national $PM_{2.5}$ standards (i.e., the national annual standard of 15 micrograms/cubic meter and the 24-hour standard of 65 micrograms/cubic meter) (U.S. EPA, 1997a). In 1998, the ARB and the air districts began designing and deploying a comprehensive network of monitoring sites to collect data for comparison to both standards (ARB, 1998). The network currently includes 82 operational monitoring sites, referred to as FRM or core State and Local Air Monitoring Stations. Data from FRM samplers at core sites are suitable for comparison with the national $PM_{2.5}$ standards and therefore, suitable for determining attainment and nonattainment status.

1. Network Design

For the purpose of planning a $PM_{2.5}$ monitoring network, the ARB and the air districts initially divided California into 18 areas called Monitoring Planning Areas (MPAs). The MPAs provide the best divisions for $PM_{2.5}$ monitoring network planning based on an analysis of population, political boundaries, geography, and meteorology. With few exceptions, the boundaries of the MPAs correspond to the boundaries of the various air basins in California. The MPAs are shown in Figure 2 (see Section A. 4. of this chapter).

During the $PM_{2.5}$ network design process, five objectives were given highest priority. These objectives are:

- Satisfy the U.S. EPA monitoring requirements.
- Represent California's air basins and provide geographical representation.
- Represent high concentrations in populated areas.
- Characterize emission sources in high concentration areas.
- Consider the need for particle measurements in ongoing special health studies.

The ARB and the air districts analyzed all available information and developed a list of sites that would best satisfy these objectives. Preference was given to adapting existing sites to $PM_{2.5}$ monitoring. The optimal site locations were selected based on population, land use, climate, emission sources, transport, characteristics of the existing monitoring network, and ongoing health studies. The rationale for selecting each of the sites was described in the three previous network descriptions (ARB, 1998; ARB, 1999; and ARB, 2000a).

The currently planned $PM_{2.5}$ network comprises 82 FRM monitoring sites, all of which are in operation. The *2000 California Particulate Matter Monitoring Network Description* (*2000 Network Description*) listed 81 sites as in operation. Since its publication, the Ventura County Air Pollution Control District has deployed an Andersen Instruments RAAS-300 sequential $PM_{2.5}$ sampler to Piru-Pacific Avenue. In addition, two sites listed in the *2000 Network Description* have been moved: Salinas #3 replaced Salinas-Natividad Road #2 in January 2000, and Portola-161 Nevada Street replaced Portola-Commercial Street in May 2000. Two further differences between the sites listed in this document and those listed in the *2000 Network Description* include: Bakersfield-410 E Planz Road corresponds to the Bakersfield-"Southeast" site and Fresno-Pacific College corresponds to the Fresno-Pacific Avenue site. Also the plans for establishing a site in a North-West Lake Tahoe have now been dropped.

As required by U.S. EPA regulations, each core site has a population-oriented location, a neighborhood scale of representation, and an approved FRM measurement method. Only data from core sites are eligible for comparison to both the annual and 24-hour national $PM_{2.5}$ standards.

In addition to collecting data for determining attainment status with respect to the national standards, many FRM sites satisfy other monitoring objectives, including transport assessment and assistance in health studies. Each of the California air basins has at least one FRM $PM_{2.5}$ mass monitoring site. Air basins with high population and expected high $PM_{2.5}$ concentrations have additional monitoring sites to provide better geographical representation.

2. NAMS Designations

Federal regulations require that some $PM_{2.5}$ mass monitoring sites within California be designated as NAMS trends sites. NAMS trends sites are long-term sites that can be used to track trends that establish progress toward attainment of the national standards. Final approval for designating sites as NAMS rests with the U.S. EPA. In the *2000 Network Description*, ARB recommended that 20 sites be designated as NAMS. The U.S. EPA has not yet taken final action in approving any of these designations.

Table 3 lists the sites in California that the ARB and the air districts have designated as NAMS trends sites for $PM_{2.5}$ mass. The list represents those sites that experienced high ambient $PM_{2.5}$ mass concentrations in 1999 and sites located in areas with high populations. In developing the list, we gave preference to sites that have been in operation for several years (monitoring PM_{10}) and that are likely to remain in operation for the foreseeable future. Also, we selected sites that broaden the geographical representation of the network and that have the most frequent sampling schedules.

Table 3
Proposed Sites in California's $PM_{2.5}$ Mass NAMS Network

Monitoring Planning Area	Site Name	AIRS Site ID
Bay Area AQMD	San Francisco-Arkansas Street	060750005
	San Jose-4th Street	060850004
	Vallejo-304 Tuolumne Street	060950004
Great Basin Unified APCD	Mammoth Lakes-Gateway HC[1]	060510001 [1]
Imperial County APCD	Calexico-Ethel Street	060250005
Mountain Counties Air Basin	Portola-161 Nevada Street[1]	060631009 [1]
	Quincy-N Church Street[1]	060631006 [1]
Sacramento Valley Air Basin	Sacramento-Del Paso Manor	060670006
San Diego County APCD	El Cajon	060730003
	San Diego-12th Avenue	060731007
San Joaquin Valley Unified APCD	Bakersfield-5558 California Avenue	060290014
	Fresno-1st Street	060190008
	Modesto-814 14th Street	060990005
	Stockton-Hazelton Street	060771002
	Visalia-N Church Street	061072002
South Coast Air Basin	Anaheim area[2]	060590001 [2]
	Azusa	060370002
	Burbank-W Palm Avenue	060371002
	Los Angeles-North Main Street	060371103
	North/South Long Beach area[3]	060374002 [3]
	Riverside-Rubidoux	060658001
Ventura County APCD	Simi Valley-Cochran Street	061112002

[1] Mammoth Lakes, Quincy, and Portola are all potentially smoke-impacted and we have proposed that one should be designated as a NAMS. Before a decision can be made, the involved agencies will need to coordinate on this, and more data will be needed from the recently opened Mammoth Lakes site.

[2] The South Coast AQMD is relocating the Anaheim-Harbor Blvd site to a new site in the Anaheim area.

[3] The South Coast AQMD plans to move the $PM_{2.5}$ FRM sampler from the North Long Beach site to a new site in the South Long Beach area, because special particulate studies conducted recently indicate that area better represents the expected maximum concentrations experienced in the greater Long Beach area.

At the time of last year's report, it was uncertain whether San Jose-4th Street or San Jose-Tully Road was the preferred site to be designated as the NAMS site in the San Jose. After consultation with the Bay Area Air Quality Management District, we agreed that San Jose-4th Street rather than San Jose-Tully Road is the preferred site to receive the NAMS designation.

Data from the NAMS monitors are used to indicate the air quality trend for the monitoring site with the highest air quality concentrations in an area. The $PM_{2.5}$ monitoring network has not been in operation for a long enough time for us to be certain that we have identified the appropriate sites. Because of these factors, the ARB and air districts will review the selection of NAMS sites as more data become available.

3. Sampler Selection

The $PM_{2.5}$ mass samplers used in California's core $PM_{2.5}$ monitoring network have been identified as FRM samplers by the U.S. EPA. The State monitoring network includes three types of FRM samplers. All but one site in the network use either the sequential Reference Ambient Air Sampler (RAAS) 2.5-300 manufactured by Andersen Instruments or the single-channel Partisol®-FRM Model 2000 sampler manufactured by Rupprecht & Patashnick (R&P). The sequential FRM samplers have been deployed for the most part in high population and/or high concentration areas to accommodate more frequent sampling (everyday or one-in-three day). The single-channel FRM samplers have been deployed in less populated areas with estimated $PM_{2.5}$ concentrations below the national standards. The exception is the Echo Summit site, which received a sequential sampler that was funded by Nevada Division of Environmental Protection. The ARB and the air districts purchased the other FRM samplers through a National Procurement Contract.

A third type of FRM sampler, the sequential Partisol® Plus Model 2025 manufactured by R&P (primary sampler and collocated sampler), is operating at the Keeler-Cerro Gordo Road site in the Great Basin Unified Air Pollution Control District (APCD). A sequential RAAS manufactured by Anderson was initially deployed at this site; however, the Great Basin Unified APCD staff encountered persistent operational problems with the sampler that seemed to be associated with stormy and moist conditions. Many of the same parts on this instrument were replaced numerous times, and the Great Basin Unified APCD was not able to get the sampler running for any extended period of time. As a result, the Great Basin Unified APCD purchased two sequential R&P samplers using funds from the Owens Lake budget. These monies are authorized under the Health and Safety Code section 42316 to provide funds for studying and mitigating the PM problem in the Owens Lake area. The sequential R&P samplers began operating at the Keeler site in May 2000.

Information about all the samplers in the FRM network is summarized in Table 4. Appendix A lists whether each site has a sequential sampler or a single-channel sampler.

Table 4
$PM_{2.5}$ FRM Samplers in California's Monitoring Network

Sampler Type	Manufacturer	Number of Samplers by Function		
		Primary	QA/QC	Total
Sequential FRM	Andersen	66	16	82
Sequential FRM	R&P	1	1	2
Single-channel FRM	R&P	15	4	19
Total		82	21	103

4. Sampler Deployment

The installation of $PM_{2.5}$ FRM sites began in 1998 and is now complete. The current deployment status is summarized in Appendix A. The samplers were deployed in a rough priority order as follows. The sites estimated to have the highest $PM_{2.5}$ concentrations in each MPA, based on data from dichotomous (dichot) samplers and/or PM_{10} data, were installed first. Areas with estimated $PM_{2.5}$ concentrations close to the national $PM_{2.5}$ standards and areas where $PM_{2.5}$ concentrations are highest during the fall and winter were also given high priority. Existing dichot sites were favored for early deployment in an effort to collect data for comparison of the dichot and FRM measurement methods. Another criterion for determining deployment was to ensure that each operating agency received at least one sampler early on to gain experience in operating the instrument.

The locations of the 82 deployed sites are shown in Figure 2.

Figure 2
$PM_{2.5}$ FRM Mass Monitoring Sites
(with Monitoring Planning Areas and Counties)

5. Sampling Frequency

According to U.S. EPA monitoring regulations, everyday sampling is required at 29 FRM $PM_{2.5}$ sites in California (two sites per area over 500,000 population and one site per Photochemical Assessment Monitoring Station (PAMS) area) (U.S. EPA, 1997c). All other sites are required to sample once every three days. The U.S. EPA, Region IX office has the authority to allow less frequent sampling as appropriate.

When the $PM_{2.5}$ network was first established, the ARB and the air districts used available dichot data and/or PM_{10} data to tailor the sampling schedule at each

site to support area designations, health studies, and other monitoring objectives. As a result, the $PM_{2.5}$ sampling schedule in California differs from the requirement. The current sampling frequencies are summarized in Table 5.

Table 5
$PM_{2.5}$ FRM Sampling Schedule in California

Sampling Schedule	Number of Sites
Same schedule year around.	11 sites sample daily
	37 sites sample 1-in-3 days
	18 sites sample 1-in-6 days
Different schedule for October-March (high season) than for April-September.	2 sites sample daily for October-March and 1-in-3 days for April-September
	4 sites sample daily for October-March and 1-in-6 days for April-September
	10 sites sample 1-in-3 days for October-March and 1-in-6 days for April-September
Total FRM sites	82

There are eleven monitoring sites in California sampling everyday for $PM_{2.5}$ on a year-round basis. Six additional sites sample everyday during the period of expected high $PM_{2.5}$ concentrations for those sites (October 1 through March 31). The remaining sites sample on a one-in-three day or one-in-six day schedule, depending on the type of sampling equipment and estimated level of $PM_{2.5}$ concentrations. Appendix A includes the sampling frequency, as approved by the U.S. EPA, Region IX, for each monitoring site in California.

Later this year, the ARB will reevaluate the sampling frequency schedules based on the $PM_{2.5}$ FRM data for 1999, 2000, and a partial 2001, as available at that time. Continuous $PM_{2.5}$ mass data will also be useful for this evaluation. The ARB will distribute a proposal for modifications to the sampling frequency schedules to the air districts and ultimately will develop a revised sampling schedule. The proposal will consider less frequent sampling, but no less than a one-in-six day schedule, for the following monitoring situations:

- Monitoring sites not likely to violate the $PM_{2.5}$ standards, or
- Monitoring sites with a correlated acceptable continuous (CAC) monitor and with concentrations well above or below the $PM_{2.5}$ standards.

Federal regulations provide for reduced FRM sampling frequency in certain cases where a continuous mass monitor is collocated with the FRM. Such a monitor is termed a correlated acceptable continuous (CAC) monitor. According to the regulations provided in 40 CFR Part 58, the selection of correlated acceptable continuous PM analyzers and procedures for correlation with the

FRM are to be in accordance with procedures approved by the Regional Administrator (U.S. EPA, 1997b). The data derived from the correlated acceptable continuous monitor are not eligible for direct comparison to the standards.

All of the $PM_{2.5}$ continuous mass monitors used in the California $PM_{2.5}$ network are beta-attenuation monitors (BAMs), but there are some significant differences between various models. As part of the proposal for modification to the sampling frequency schedules, the ARB will work with the air districts to develop guidelines for establishing correlations between BAMs and FRMs. The proposal will not only recommend reducing sampling frequency at sites sampling everyday but also at sites with a one-in-three day sampling schedule.

If approved by the U.S. EPA Region IX, the new sampling schedule for sites not likely to violate the $PM_{2.5}$ standards would become effective at the beginning of 2002. Before the sampling frequency can be reduced at a site based on a CAC monitor, the ARB would like to see sufficient collocated data collected, including high season data, to establish an adequate correlation. The guidelines would address this. More frequent sampling would be considered during next year's annual network review at any site with $PM_{2.5}$ concentrations close to a standard that is sampling once every six days throughout the year.

6. Quality Assurance Plan and Audits

All of the agencies operating $PM_{2.5}$ monitors in California developed $PM_{2.5}$ Quality Assurance Project Plans (QAPPs) which are part of the overall network plan. The U.S. EPA has conditionally approved these QAPPs which cover administrative, laboratory, and field activities. Most districts referred to the ARB's QAPP rather than developing their own QAPP and included district-specific information and procedures as necessary. Before the California QAPPs receive full approval, the U.S. EPA must complete a part of the QAPP for which it is responsible, dealing with data quality objectives. The ARB and the U.S. EPA have reached agreement on audit requirements. The ARB is in the process of revising the audit element of the QAPP.

a. Collocated Samplers

The purpose of collocated samplers and the FRM performance evaluation is to estimate the precision and bias of the various $PM_{2.5}$ samplers. According to 40 CFR Part 58, Appendix A, Section 3.5.2 (U.S. EPA, 1997d), at least 25 percent of $PM_{2.5}$ monitoring sites must operate collocated samplers for each method designation. The two kinds of sequential samplers and the single-channel sampler used in California's $PM_{2.5}$ monitoring network all have different method designations. The ARB and the air districts have deployed collocated sequential Andersen FRM samplers to sixteen sites, collocated sequential Rupprecht and Patashnick FRM samplers to one site, and collocated

single-channel Rupprecht and Patashnick FRM samplers to four sites (refer to Table 4). The specific site locations are identified in Appendix A.

The ARB and the air districts selected collocated $PM_{2.5}$ sites based on the following criteria listed in order of importance:

- Measured or estimated $PM_{2.5}$ concentrations.
- Diversity of operating agencies.
- Geographical representation.
- Practical considerations such as available space.

All collocated samplers summarized in the *2000 Network Description* continue to operate, with one exception. The collocated sampler that was listed at the Anaheim-Harbor Blvd. site in the South Coast Air Basin has been moved to the Azusa site. Anaheim-Harbor Blvd. is a temporary station with inadequate space and power for the collocated sampler. The air district is working to establish a permanent Anaheim monitoring site. When that occurs, the collocated sampler will be moved to the new Anaheim site.

b. $PM_{2.5}$ Laboratory Pre-Certification Program

In order to assure the quality of the $PM_{2.5}$ air monitoring data and to facilitate a timely initiation of laboratory operations, the ARB implemented a Laboratory Pre-Certification Program. The program includes a laboratory pre-certification questionnaire and an on-site visit of the laboratory. The laboratory pre-certification questionnaire addresses requirements that a laboratory conducting $PM_{2.5}$ mass analysis determinations must follow. The questionnaire also includes recommendations on how to improve the overall quality of a laboratory's $PM_{2.5}$ operations. The requirements are found primarily in 40 CFR Part 50, Appendix L, Section 8.0 (U.S. EPA, 1997e). Additionally, recommendations are found in U.S. EPA's Quality Assurance Handbook, Volume II, Method 2.12 (U.S. EPA, 1989). The pre-certification questionnaire helps laboratories become aware of what is necessary to assure good quality data. As a follow-up to the pre-certification questionnaire, staff from the ARB Quality Assurance Section conduct an on-site visit of the laboratory. Each laboratory must be pre-certified before submitting $PM_{2.5}$ data to the U.S. EPA Aerometric Information Retrieval System (AIRS) - Air Quality Subsystem (AQS).

There are eight pre-certified laboratories in California: Bay Area AQMD, ARB, Great Basin Unified APCD, Lake County AQMD, Mojave Desert AQMD, San Diego County APCD, South Coast AQMD, and Ventura County APCD. All eight laboratories meet the necessary conditions for submitting data to the U.S. EPA AIRS-AQS. The methodology used to analyze the $PM_{2.5}$ mass samples collected on Teflon filters is summarized in the Standard Operating Procedure for Mass Analysis of Fine Particulate Collected on Teflon Filters included in the QAPP.

c. $PM_{2.5}$ Mass Analysis System and Performance Audits

The ARB Quality Assurance Section has implemented a $PM_{2.5}$ Laboratory Mass Analysis System Audit Program. The audit entails completion of a laboratory operations system audit questionnaire and an on-site inspection and assessment of the total measurement system (sample collection, sample analysis, data processing, etc.). Included with the system audit is a performance audit consisting of an on-site review to check the accuracy of the $PM_{2.5}$ filter weighing balance(s), and relative humidity and temperature sensors, and a check of the laboratory operations to verify their ability to generate data of acceptable quality. The performance audits are conducted annually, and follow the initial system audit. The system audits and annual performance audits/checks will help to ensure comparable results among the laboratories.

d. Sampler Performance and System Audits of Field Samplers

The primary goal of an auditing program is to identify system errors that may result in suspect or invalid data. The audit procedures described here provide quantitative estimates of a $PM_{2.5}$ FRM mass sampler's performance. These quantitative values consist of the flow rate percent difference, the design flow rate percent difference, the ambient temperature difference, the filter temperature difference, and the barometric pressure difference. In addition, for multiple filter samplers, the audit procedures provide quantitative values of the inactive filter temperature difference and the dry gas meter (DGM) temperature difference.

The flow rate percent difference indicates the accuracy of the sampler's indicated flow rate by comparing the indicated flow rate measurement with the measurement from an audit transfer standard. The design flow rate percent difference determines how closely the sampler's flow rate matches the inlet design flow rate under ideal operating conditions. The ambient temperature, filter temperature, and barometric pressure differences reflect the difference between the audit measurement for temperature or pressure and the respective measurement indicated by the sampler.

A calibrated transfer standard mass flow meter (MFM) is used to measure the sampler's operational flow rate. The sampler's indicated flow rate is then compared with the actual flow rate indicated by the MFM. The sampler's indicated flow is also compared with the design flow rate of 16.67 liters per minute. Audit techniques may vary with different models of samplers due to differences in such things as sampler configuration and sampler software.

The purpose of a field sampler system audit is to check if the monitoring site meets $PM_{2.5}$ siting criteria and if the site and equipment are clean and properly maintained. The initial system audit consists of completing a Site Survey Report. Annually thereafter, during each sampler performance audit, the Site Survey Report is checked for accuracy and updated as necessary. As a result of an

audit, data may be deleted or corrected, or siting or operation conditions may be changed.

The U.S. EPA requires four quarterly audits per year for all $PM_{2.5}$ FRM mass samplers. The ARB conducts one of the quarterly audits which consists of a performance audit and a system audit. The remaining three quarterly audits are conducted by air district or contractor personnel. Audit results are available upon request from the Quality Assurance Section at the ARB.

e. National Performance Audit

The National Performance Audit Program is a quality assurance activity that is used to evaluate measurement system bias of the $PM_{2.5}$ FRM monitoring network. The pertinent regulations for this performance evaluation are found in 40 CFR Part 58, Appendix A, Section 3.5.3 (U.S. EPA, 1997d). The strategy is to collocate a portable FRM $PM_{2.5}$ air sampling instrument within 1 to 4 meters of a routine NAMS/SLAMS air monitoring instrument, operate both monitors as required in the Federal Reference Method and standard operating procedures, and compare the results. The U.S. EPA implemented this program, and each year 25 percent of the SLAMS/NAMS monitors are to be identified for performance evaluation at a frequency of four times per year.

B. Continuous $PM_{2.5}$ Mass Samplers

The primary objective of continuous $PM_{2.5}$ mass monitoring is to obtain diurnally resolved data. These data are useful for public reporting, understanding diurnal and episodic behavior of fine particles, background monitoring, and transport assessment.

In 2000 and the first half of 2001, ARB and the air districts deployed continuous $PM_{2.5}$ mass monitors at 21 sites throughout California. The *1999 California Particulate Matter Monitoring Network Description* (*1999 Network Description*) and *2000 Network Description* included plans for deploying seventeen of them. Four sites received monitors in addition to those listed in the two *Network Descriptions*: Altamont Pass, Gridley, Sacramento-T Street, and Salinas #3. A monitor was deployed to Altamont Pass to support the study of particulate transport between the San Francisco Bay Area and the San Joaquin Valley. Due to lease constraints, monitoring at Altamont Pass was discontinued. Later this year, the monitor that was originally deployed at Altamont Pass will be relocated to Patterson Pass where it will be used as part of the regular monitoring network. The monitor deployed to Gridley supports the Sacramento Valley smoke management program in place of the Colusa-Sunrise Boulevard or Yuba City-Almond Street sites suggested for that purpose in the *2000 Network Description*. The Sacramento-T Street site is atop the ARB's Monitoring and Laboratory Division headquarters building, and was deployed to allow ARB staff to gain operational experience with the monitor.

Finally, Monterey Bay Unified APCD, using its own funds, has deployed a continuous $PM_{2.5}$ mass monitor to the Salinas #3 site.

The deployed sites along with funding sources for the monitors are listed in Table 6. Many of the deployed monitors, and most of those not yet deployed, are funded from sources other than the Section 103 Grants from the U.S. EPA. Appendix B contains a complete listing of deployed and planned continuous mass monitors.

Table 6
Deployed Continuous $PM_{2.5}$ Mass Monitors

Monitoring Planning Area	Site Name	AIRS Site ID	Funding Source
Bay Area AQMD	Livermore-793 Rincon Avenue	060010007	1999 103 Grant
	Point Reyes		1999 103 Grant
	San Francisco-Arkansas Street	060750005	1999 103 Grant
	San Jose-4th Street	060850004	1999 103 Grant
Coachella Valley	Indio-Jackson Street	060652002	District Funds
Imperial County APCD	Calexico-East	060250006	Border Program[1]
	Calexico-Ethel Street	060250005	Border Program[1]
Monterey Bay Unified APCD	Salinas #3	060531003	District Funds
Sacramento Valley Air Basin	Elk Grove-Bruceville Road	060670011	District Funds
	Gridley	060074001	ARB
	Sacramento-Del Paso Manor	060670006	1999 103 Grant
	Sacramento-T Street	060670010	CRPAQS[2]
San Diego County APCD	**Escondido-E Valley Parkway**	060731002	1999 103 Grant
	Otay Mesa-Paseo International	060732007	Border Program[1]
San Joaquin Valley Unified APCD	Bakersfield-5558 California Avenue	060290014	CRPAQS[2]
	Fresno-1st Street	060190008	EPA Supersite
South Coast Air Basin	Banning-South Hathaway Street	060650012	District Funds
	Burbank-W Palm Avenue	060371002	ARB
	Los Angeles-North Main Street	060371103	1999 103 Grant
	Riverside-Rubidoux	060658001	1999 103 Grant
Ventura County APCD	San Nicolas Island		1999 103 Grant

Sites with collocated monitors shown in *italics*. Sites required by federal regulations shown in **bold**.

[1] California-Mexico Border Air Monitoring Program. The ARB owns these monitors.
[2] California Regional $PM_{10}/PM_{2.5}$ Air Quality Study. The CRPAQS Joint Power Authority has now distributed the monitors to the agencies operating the sites.

Figure 3 shows the locations of all deployed and planned continuous mass monitors.

Figure 3
$PM_{2.5}$ Continuous Mass Monitoring Sites
(with Monitoring Planning Areas and Counties)

Federal regulation requires that eight sites, each located in a metropolitan area with a population greater than one million, receive continuous $PM_{2.5}$ mass monitors. Of these required sites, six have been deployed (as shown in bold in Table 6). Deployment to the two sites that do not yet have a monitor, in the Anaheim area and Oakland area, will occur once suitable sites are established.

Federal regulations also require continuous mass monitors for a background monitoring site and a transport monitoring site in California. Two background monitors, those at Point Reyes and San Nicolas Island, are deployed. Work is in progress to locate a monitor at another background site, San Rafael Wilderness. Due to current uncertainty about the extent of pollutant transport and the best monitoring configuration, only one corridor was selected for initial transport

assessment. The pollutant transport corridor between the Bay Area AQMD and San Joaquin Valley Unified APCD via Altamont Pass was selected as the most appropriate corridor for initial assessment because of its documented history of ozone transport, availability of air quality and meteorology data from special studies, and existing infrastructure. The corridor was to have continuous $PM_{2.5}$ mass measurements collected at three sites: Livermore-793 Rincon Avenue, Altamont Pass, and Tracy. The Livermore-793 Rincon Avenue site is located upwind of the pass and is the only site operating a continuous mass monitor at this time. The Altamont Pass site was collecting continuous $PM_{2.5}$ mass measurements in the pass itself during CRPAQS, but had to be relocated due to lease constraints upon completion of the study. The replacement site, located in Patterson Pass, will begin operation later this year. The Tracy site, located downwind of the pass, will have a continuous mass monitor deployed later this summer.

All continuous $PM_{2.5}$ monitors purchased by the ARB are MetOne Model 1020 monitors that have been specifically configured to ARB specifications. The monitors purchased by the air districts or the California Regional PM_{10}/$PM_{2.5}$ Air Quality Study (CRPAQS) are not necessarily the same model as those purchased by ARB, though all are BAMs. The ARB requested that the manufacturer set up the instruments in a certain way, after determining that different models and different configurations of the BAMs could give significantly different data results. This, in part, is based on an intercomparison study of different BAMs in the Bakersfield area. Some, but not all, air districts are making sure that the BAMs that they purchase meet ARB specifications. Future analyses of BAM data will need to carefully consider the differences. The ARB is working with the air districts to promote the deployment of BAMs configured to ARB specifications at the most important $PM_{2.5}$ monitoring sites.

The *2000 Network Description* called for four continuous $PM_{2.5}$ mass monitors to be deployed as collocated monitors. To date, one site, Calexico-Ethel Street, has received a collocated monitor.

C. $PM_{2.5}$ Speciation Samplers

Speciation samplers provide valuable information about the composition (and ultimately the sources) of $PM_{2.5}$ pollution. The chemical speciation network in California includes two components: NAMS speciation sites for measuring long-term trends of selected $PM_{2.5}$ constituents and SLAMS speciation sites to collect data needed to develop an effective State Implementation Plan (U.S. EPA, 1999a).

Federal regulations require seven speciation sites in California as part of a nationwide network of NAMS speciation sites. In compliance with these regulations, the sites listed below were selected as NAMS speciation sites:

- Bakersfield-5558 California Avenue
- El Cajon-Redwood Avenue
- Fresno-1st Street
- Riverside-Rubidoux
- Sacramento-Del Paso Manor
- San Jose-4th Street
- Simi Valley-Cochran Street

All of the NAMS speciation sites, with exception of Simi Valley-Cochran Street, have already been deployed. A speciation sampler will be deployed to Simi Valley-Cochran Street later this year. The rationale for selecting these sites is described in the *1999 Network Description*. The sampling frequency at these sites is one 24-hour sample every third day except for the initial startup period during which sampling frequency at some sites was one 24-hour sample every sixth day. Selection of these seven sites as NAMS speciation trend sites should be considered tentative until sufficient data from the California network are available for evaluation.

The U.S. EPA funded the purchase of the NAMS speciation samplers. In addition, U.S. EPA has specified the types of samplers that may be used in order to ensure consistency and comparability of data throughout the nationwide network. In compliance with the regulations, Spiral Aerosol Speciation Samplers (SASS) were selected for the California's NAMS speciation sites.

The target species of interest for the $PM_{2.5}$ NAMS speciation program consist of:

- anions (particulate sulfate and nitrate) and cations (particulate ammonium, sodium, and potassium);
- trace elements (about 20 key elements from sodium through lead on the periodic table);
- total carbon and semivolatile organic aerosol constituents; and
- particulate mass.

The South Coast Air Quality Management District has in previous years operated a network of $PM_{2.5}$ speciation samplers as part of their Particulate Technical Enhancement Program (PTEP). The PTEP samplers are undergoing major refurbishment at this time and several will be deployed over the next twelve months. Additional information about PTEP is included in Chapter 3, Section B. 1. and in Chapter 5, Section F.

Most of the effort of designing the SLAMS speciation monitoring network is occurring in the 2001 network planning cycle. For a more complete discussion, refer to Chapter 3, Section B.

D. Meteorological Equipment

The *1999 Network Description* proposed that meteorological equipment be added at the following sites: Redding-Health Department in the Sacramento Valley MPA, Ridgecrest-Las Flores Avenue in the Mojave Desert MPA, and Tracy in the San Joaquin Valley MPA. The meteorological data, along with FRM or continuous $PM_{2.5}$ mass measurements collected at these sites, will be used for transport assessment. The meteorological instruments needed for these sites include wind speed, wind direction, outside temperature, and relative humidity. The meteorological equipment for these sites has been deployed and is currently operating.

E. Background and Transport Monitoring

The current status of the background monitoring and transport monitoring components of the $PM_{2.5}$ network is discussed in Section B., above.

CHAPTER 3
PLANNED $PM_{2.5}$ NETWORK ACTIVITY

This chapter addresses plans for expanding the $PM_{2.5}$ network during the next twelve months. Included are continuous mass samplers, speciation samplers, background monitors, and special support equipment. Most of the planned monitoring network expansion focuses on continuous mass and speciation samplers. A summary of the main types of $PM_{2.5}$ monitoring instruments being planned for each $PM_{2.5}$ monitoring site, along with what already exists, is included in Appendix B.

A. Continuous Mass Monitors

The *1999 Network Description* called for the ARB and the air districts to deploy 15 continuous $PM_{2.5}$ mass monitors, funded via the 1999 Section 103 Grant, for public reporting, transport assessment, background monitoring, and better temporal representation. In addition, the *2000 Network Description* called for continuous mass monitoring to be established at as many as 18 other sites throughout the State, depending on monitor availability. As discussed in Chapter 2, Section B., 21 monitors have been deployed, 17 of which were listed in the *1999* and *2000 Network Descriptions*.

Table 7 lists 15 continuous $PM_{2.5}$ mass monitors that we expect to be deployed in the next year. Two sites, Chico-Manzanita Avenue and Folsom-Natoma Street, are in addition to those listed in the *1999* and *2000 Network Descriptions*. Concentrations at the Chico-Manzanita Avenue site are the highest in the northern Sacramento Valley. The site began collecting $PM_{2.5}$ FRM data in December 1998. Since then, the site exceeded the national 24-hour $PM_{2.5}$ standard on four occasions, with concentrations of 98 $\mu g/m^3$, 73 $\mu g/m^3$, 70 $\mu g/m^3$, and 69 $\mu g/m^3$. The annual average $PM_{2.5}$ concentrations for 1999 and 2000 exceeded the annual $PM_{2.5}$ standard. Currently the site is equipped with a single-channel FRM sampler operating on a one-in-six day schedule. We need to collect more frequent data to have a better understanding of the nature and extent of the fine particulate problem in the northern Sacramento Valley. Use of a continuous mass monitor at this site has the special benefit of being useful for the agricultural burning program in the Sacramento Valley. For the Folsom-Natoma Street site, the Sacramento Metropolitan Air Quality Management District plans to purchase a continuous mass monitor if district funds are available for this purpose. Additionally, the deployment of a monitor to the San Diego-12th Avenue site should be considered tentative pending determination that adequate space is available at the site.

Several sites listed in the *2000 Network Description* have been removed from consideration for receipt of a continuous mass monitor. Two of these sites, Mammoth Lakes-Gateway HC and Quincy-N Church Street, were listed as alternative sites to assess smoke impact. After discussions with the two air districts involved, we determined that a site in the Mountain Counties Air Basin

Monitoring Planning Area (MPA) was preferable to the Mammoth Lakes site for this purpose. We suggested in last year's *Network Description* that Quincy-N Church Street be used for this purpose. We have since determined, in cooperation with the air district, that the Portola-161 Nevada Street site typically experiences higher $PM_{2.5}$ concentrations and is therefore a better location. We expect a monitor to be deployed to Portola this year.

Table 7
Expected Continuous Mass Monitor Deployments for the Next Year

Monitoring Planning Area	Site Name	AIRS Site ID	Funding Source
Bay Area AQMD	Oakland area		1999 103 Grant
	Patterson Pass		CRPAQS[1]
Mountain Counties Air Basin	Portola-161 Nevada Street	060631009	ARB
	Yosemite Village	060431001	1999 103 Grant
Sacramento Valley Air Basin	Chico-Manzanita Avenue	060070002	ARB
	Folsom-Natoma Street	060670012	District
San Diego County APCD	San Diego-12th Avenue[2]	060731007	Border Program[3]
San Joaquin Valley Unified APCD	Modesto-814 14th Street	060990005	CRPAQS[1]
	Tracy		1999 103 Grant
	Visalia-N Church Street	061072002	CRPAQS[1]
Santa Barbara County APCD	San Rafael Wilderness		1999 103 Grant
South Coast Air Basin	Anaheim area		1999 103 Grant
	Azusa	060370002	ARB
	South Long Beach		ARB
Ventura County APCD	Simi Valley-Cochran Street	061112002	ARB

Fewer monitors than anticipated in the *2000 Network Description* were ultimately available for deployment. As a result, plans to deploy monitors to Vallejo-304 Tuolumne Street and Stockton-Hazelton Street have been dropped.

The *2000 Network Description* called for continuous $PM_{2.5}$ mass monitors to be deployed to four sites for use as collocated monitors, but did not specify which sites would receive the monitors. As stated in Chapter 2, Section B., one collocated monitor has been deployed to the Calexico-Ethel Street site. This year we plan to deploy collocated monitors to the Bakersfield-5558 California Avenue, Chico-Manzanita Avenue, and Riverside-Rubidoux sites. The ARB will purchase a continuous mass monitor for the Chico-Manzanita Avenue site using Section 103 Grant funding from the U.S. EPA. The other two collocated continuous mass monitors to be deployed

[1] California Regional $PM_{10}/PM_{2.5}$ Air Quality Study. The CRPAQS Joint Power Authority has now distributed the monitors to the agencies operating the sites.
[2] There may not be adequate space at the San Diego-12th Street site to deploy a continuous mass monitor. The air district and the ARB are discussing the situation.
[3] California-Mexico Border Air Monitoring Program. The ARB owns these monitors.

this year are ARB monitors funded from sources other than Section 103 Grants. Data from these four collocated sites will allow performance comparisons between the instruments under differing environmental conditions in areas with high concentrations of ambient $PM_{2.5}$.

B. Speciation Samplers

Speciation samplers provide valuable information about the composition of $PM_{2.5}$ pollution. The chemical speciation network in California includes two components: NAMS speciation sites for measuring long-term trends of selected $PM_{2.5}$ constituents and SLAMS speciation sites for collecting the data needed to develop an effective State Implementation Plan (SIP). As discussed in Chapter 2, Section C., all of the NAMS speciation sites, with exception of Simi Valley-Cochran Street, have been deployed during the past year and a half.

This year, we are focusing on expansion of the SLAMS network. We evaluated 1999 and available 2000 $PM_{2.5}$ mass data to help determine which areas would be the most likely to benefit from the availability of speciation information. We considered two primary factors in determining the most appropriate locations for deployment of the SLAMS speciation samplers:

- **Whether or not an area is likely to exceed a national $PM_{2.5}$ standard.**
  Preference was first given to locating a monitor at the highest site in each area that exceeds or is close to exceeding the daily or annual national standards.
- **In areas that exceed one or both of the national standards, how widespread the exceedance problem appears to be.**
  Preference was then given to allocating additional monitors to areas that have experienced widespread exceedances. The sites allocated a monitor were chosen to represent those subregions that have experienced high concentrations, while maintaining an adequate geographical representation of the broader exceedance area.

1. Filter-Based $PM_{2.5}$ Speciation Monitors

Filter-based $PM_{2.5}$ speciation samplers are used as part of the NAMS and SLAMS networks. As discussed in Section 2. C., a NAMS speciation sampler is yet to be deployed at the Simi Valley-Cochran Street monitoring site. This site is expected to begin operation in the fall of 2001.

ARB and the air districts plan to deploy filter-based speciation monitors, as SLAMS monitors, to the following sites during the next year:

- Anaheim area (refurbished PTEP sampler)
- Calexico-Ethel Street (SASS funded with ARB 2001 103 grant)
- Chico-Manzanita Avenue (SASS funded with ARB 2001 103 grant)
- Escondido-E Valley Parkway (SASS funded with SDAPCD 2001 103 grant)
- Fontana-Arrow Highway (refurbished PTEP sampler)
- Los Angeles-North Main Street (SASS funded with SCAQMD 2001 103 grant and refurbished PTEP sampler)
- Modesto-814 14th Street (SASS funded with ARB 2001 103 grant)
- Portola-161 Nevada Street (SASS funded with ARB 2001 103 grant)
- Sacramento-T Street (SASS funded with ARB 2001 103 grant)
- Riverside-Rubidoux (Refurbished PTEP sampler)
- Visalia-N Church Street (SASS funded with ARB 2001 103 grant)

These planned deployments are listed in Table 8.

Based upon its evaluation of several types of monitors, ARB determined that the SASS (i.e., Spiral Aerosol Speciation Samplers) monitor offers significant operational and performance advantages over other filter-based speciation monitors. Deploying SASS monitors at the SLAMS speciation sites would also be consistent with the SASS monitors that have been deployed at the six NAMS speciation sites. As a result, we expect to deploy SASS monitors at most of sites listed above. The exception to this for the South Coast is discussed below.

These additional SASS monitors should use a one-in-three day sampling frequency for the first high season they are in operation, and a one-in-six day frequency for the remainder of the first year. The San Diego County APCD plans to operate their SLAMS speciation sampler on a one-in-six day schedule permanently. We will re-evaluate the sampling frequency for subsequent years in next year's *Network Description*. Chemical species measured at SLAMS speciation sites will initially be the same as for the routine NAMS. This may change in the future as we tailor measurements at each site to meet data objectives. Refer to Section 2. C. for a discussion of the NAMS target species.

The monitoring site at Riverside-Rubidoux operates a collocated SASS sampler for quality assurance and quality control purposes. Later this year we will determine where to deploy another collocated SASS sampler. This is to meet the U.S. EPA recommendation that ten percent of filter-based speciation monitors be collocated. This additional SASS will be purchased using Section 103 Grant funds.

Table 8
Existing and Proposed $PM_{2.5}$ Speciation Monitoring Network in California

"24-hour" stands for a filter-based $PM_{2.5}$ sampler that collects 24 hour samples. Most 24-hour speciation samplers, with exception of four PTEP samplers in the South Coast AQMD, are Spiral Aerosol Speciation Samplers. "Cont. NO3" and "Cont. SO4" stand for a continuous $PM_{2.5}$ nitrate and a continuous $PM_{2.5}$ sulfate monitors, respectively. "OC/EC" stands for a continuous $PM_{2.5}$ monitor for organic carbon (OC) and elemental carbon (EC). "Aethelometer" stands for a continuous monitor that measures black soot. The labels indicate who owns or would own the monitor (ARB: Air Resources Board; Dist.: the air district; EPA-SS: U.S. EPA at the supersite). '99 and '01 indicate that the funding comes from the 1999 or 2001 Section 103 grant. All 24-hour samplers labeled as ARB '99 and Dist.'99 are $PM_{2.5}$ speciation NAMS monitors.

Site Location (by MPA)	AIRS Site ID	$PM_{2.5}$ Speciation Sampling Method				
		24-hour	Cont. NO3	Aethelo-meter	OC/EC	Cont. SO4
Bay Area AQMD						
San Jose-4th Street	060850004	Dist.'99		Dist.		
Imperial County APCD						
Calexico-Ethel Street	060250005	ARB '01				
Mountain Counties Air Basin						
Portola-161 Nevada Street	060631008	ARB'01				
Sacramento Valley Air Basin						
Chico-Manzanita Avenue	060070002	ARB '01		*ARB*		
Sacramento-Del Paso Manor	060670006	Dist.'99	ARB	Dist.		
Sacramento-T Street	060670010	ARB '01				
San Diego County APCD						
El Cajon-Redwood Avenue	060730003	Dist.'99				
Escondido-E Valley Parkway	060731002	Dist.'01				
San Joaquin Valley Unified APCD						
Bakersfield-5558 California Ave	060290014	ARB '99	ARB	ARB		ARB
Corcoran-Patterson Avenue	060310004		Dist.	Dist.		
Fresno-1st Street	060190008	ARB '99	ARB(2)	EPA-SS(2)	EPA-SS	ARB
Modesto-814 14th Street	060990005	ARB '01	ARB	ARB		
Oakhurst				Dist.		
Visalia-N Church Street	061072002	ARB '01	ARB	ARB		
South Coast Air Basin						
Anaheim area	060590001	Dist.[1]	ARB	ARB		
Azusa	060370002		*ARB*			
Burbank-W Palm Avenue	060371002		*ARB*			
Fontana-Arrow Highway	060712002	Dist.[1]	*ARB*			
Los Angeles-North Main Street	060371103	Dist. '01[1]	*ARB*	*ARB*		
Riverside-Rubidoux	060658001	Dist.'99 (2)[1]	ARB	ARB		
Ventura County APCD						
Simi Valley-Cochran Street	061112002	Dist.'99				

Deployments shown in *italics* are subject to monitor availability. See the text for more information.

[1] Fontana-Arrow Highway and a new site in Anaheim area will use refurbished PTEP samplers. Los Angeles-North Main Street and Riverside-Rubidoux will have both PTEP and SASS samplers operating in parallel. Riverside-Rubidoux will also have a collocated SASS sampler.

The South Coast Air Quality Management District has in previous years operated a network of $PM_{2.5}$ speciation samplers as part of their Particulate Technical Enhancement Program (PTEP). The PTEP samplers are undergoing major refurbishment at this time and are expected to be deployed this August to Fontana-Arrow Highway, Los Angeles-North Main Street, and Riverside-Rubidoux. A PTEP sampler will also be deployed to a new site in the Anaheim area later this year or early in 2002. Two of these sites, Riverside-Rubidoux and Los Angeles-North Main Street, will operate PTEP and SASS samplers in parallel to determine relationships between the two samplers. This may allow for the future replacement of the PTEP samplers with SASS samplers by establishing continuity between the historical PTEP data and future SASS data.

2. Continuous $PM_{2.5}$ Speciation Monitors

The ARB and the air districts plan to deploy four types of continuous $PM_{2.5}$ speciation monitors - continuous nitrate, continuous sulfate, aethelometer, and OC/EC (i.e., Organic Carbon/Elemental Carbon) - during the next year. These monitors were purchased through funding other than Section 103 Grant funds. Table 8 lists these deployments. The ARB-owned equipment may be redeployed in the future as program needs change.

a. Nitrate Monitors

There are eight or nine nitrate monitors that the ARB expects to have available for deployment. We plan to deploy eight nitrate monitors, including a collocated monitor at Fresno-1st Street, at the seven sites listed in Table 8 with the ARB label in non-italicized text. We anticipate high $PM_{2.5}$ nitrate concentrations at these seven sites, based on an evaluation of PM_{10} nitrate data collected over the last several years. If there is an additional monitor available, we propose to deploy it at a site in the South Coast Air Basin (such as Azusa, Burbank-W Palm Avenue, Fontana-Arrow Highway, or Los Angeles-North Main Street). Final assignment of the remaining monitor will be made after further evaluation. These potential deployments are shown in italics in Table 8. In addition, the San Joaquin Valley Unified Air Pollution Control District plans to deploy a continuous nitrate monitor at the Corcoran-Patterson Avenue site. The ARB plans to purchase another continuous nitrate monitor using Section 103 Grant funds. This monitor would be a reserve monitor, used when repairs are needed to a deployed monitor, for example.

b. Aethelometers

About seven aethelometers have become available to the ARB for deployment. In addition, the Fresno Supersite has two aethelometers, and three districts have aethelometers. Aethelometers generate hourly (and even every-five-minute) average measurements of black soot, which can be related to elemental carbon.

In Table 8, we list planned aethelometer deployments. The ARB monitors will be deployed to sites in areas where we expect to see the highest levels of ambient carbon. We evaluated ambient carbon data available from the ARB's PM_{10} filter analyses, TEP 2000 data for the South Coast, and a partial year of 2000 data from a Bay Area AQMD SASS. The number of monitors that will ultimately become available for permanent deployment to the $PM_{2.5}$ network is uncertain. Some of the monitors may be diverted to support California's Senate Bill 25 Children's Health initiative. Five of the sites listed in Table 5 will get priority over any additional sites in the deployment of the ARB aethelometers. If there are sufficient monitors for additional sites, we propose that the monitors be deployed at Chico-Manzanita Avenue and/or Los Angeles-North Main Street. This potential deployment is shown in italics in Table 8.

An attempt will be made to collocate two aethelometers at the Fresno Supersite. The two aethelometers currently at the Supersite are much different models. We will evaluate collocating two later-model aethelometers at the Supersite, and relocating one of the Supersite aethelometers elsewhere. In addition to the ARB and Fresno Supersite aethelometers, three districts own a total of four aethelometers. Two of these aethelometers are deployed as listed in Table 8. The San Joaquin Valley Unified APCD owns the other two aethelometers. The district plans to deploy one this year at Corcoran-Patterson Avenue and a second one at a site in Oakhurst in 2002.

c. Organic Carbon/Elemental Carbon (OC/EC) Monitors and Sulfate Monitors

There is one OC/EC monitor and two sulfate monitors available for deployment. The ARB plans to deploy these monitors as listed in Table 8. We consider both of these types of monitors to be in an earlier developmental stage than are the continuous nitrate monitors and the aethelometers. The data performance of the existing OC/EC monitors shows a large negative bias compared to filter-based samplers. The OC/EC units also require significant maintenance.

A new generation of OC/EC analyzer should be available in the next year. We plan to purchase two or three of the new analyzers, using Section 103 Grant funds, in the next year. No decisions have yet been made about where these analyzers will be deployed. It is likely that they will initially be deployed to Fresno-1st Street and Bakersfield-5558 California Avenue. By deploying one of

the new units to Fresno-1st Street, the comparability to the existing OC/EC monitor can be assessed.

The ARB also plans to purchase another continuous sulfate monitor using Section 103 Grant funds. This monitor would be a reserve monitor, used when repairs are needed to a deployed monitor, for example.

C. Background Monitoring

Background sites are intended to quantify regionally representative $PM_{2.5}$ concentrations for sites located away from populated areas and other significant emission sources. Background concentrations for the $PM_{2.5}$ program are defined as concentrations that would be observed in the absence of anthropogenic emissions of PM and the aerosol particles formed from anthropogenic precursor emissions of volatile organic compounds, nitrogen oxides, and sulfur oxides. Background monitoring data are important for developing control plans in areas expected to exceed the $PM_{2.5}$ standards.

Two background sites in California began operation in the last year - Point Reyes and San Nicolas Island. One background site, San Rafael Wilderness, will be deployed in the next year.

The Point Reyes National Seashore site has, and San Rafael Wilderness site will have, an IMPROVE sampler (filter-based samplers installed as part of the IMPROVE network) operating in parallel with a continuous $PM_{2.5}$ mass sampler. By siting the $PM_{2.5}$ background monitoring at IMPROVE sites, analysts can take advantage of historical and current IMPROVE mass and speciation data. The IMPROVE data, along with continuous $PM_{2.5}$ mass data and meteorological measurements, will be useful in identifying divergences from background conditions, such as impacts of wildfires and sea salt. The San Nicolas Island site is equipped with a continuous $PM_{2.5}$ mass sampler.

D. Transport Monitoring

As discussed in Chapter 2, Section B., three sites were selected to monitor pollutant transport between the Bay Area AQMD and San Joaquin Valley Unified APCD, Livermore-793 Rincon Avenue, Altamont Pass, and Tracy. Only one of these sites, Livermore-793 Rincon Avenue, operates a continuous $PM_{2.5}$ mass monitor at this time. The second site, Altamont Pass, was in operation during CRPAQS but had to be relocated due to lease constraints. The Bay Area AQMD will begin operating the replacement site, Patterson Pass, later this year. The San Joaquin Valley Unified APCD plans to deploy a BAM at the Tracy site later this summer.

E. Real Time Data Availability

We are also interested in ensuring the collection and timely reporting of the data. Making data available for "real time" public reporting allows the general public, as well as air quality managers, greater use of the data. Equipment limitations can be an obstacle to making data readily available. To this end, a data logger will be added to the Portola-161 Nevada Street site to enable the deployment of a continuous $PM_{2.5}$ mass monitor at the site.

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CHAPTER 4

DATA ANALYSIS, COMPLETENESS, AND DISTRIBUTION

A. Data Analysis

Data derived from the $PM_{2.5}$ monitoring network include both aerosol mass measurements and chemically-resolved or speciated data. Mass measurements are used principally for identifying areas as attainment or nonattainment for the national $PM_{2.5}$ standards. The mass data will also be useful for assessing trends in ambient $PM_{2.5}$ concentrations. Speciated $PM_{2.5}$ data will be used to assess trends and develop emission control measures aimed at reducing aerosol emissions as they relate to the SIP. This involves emission inventory and air quality model evaluation, source attribution analysis, and tracking the success of emission control programs.

To assess the spatial and temporal characteristics of $PM_{2.5}$ concentrations throughout California, we analyzed monitoring data collected from 1997 through 1999. Since data from the newly deployed FRM network are available for only 1999 and 2000, we also used data from the existing PM_{10} monitoring network, including data from Size Selective Inlet (SSI) samplers and dichotomous PM_{10}/$PM_{2.5}$ samplers. The SSI PM_{10} is a high volume sampler that measures PM_{10} mass and five species: nitrate, sulfate, ammonia, chloride, and total carbon. The dichotomous sampler measures mass in both the 0-2.5 µm (fine particle fraction) and 2.5-10 µm (coarse particulate matter) size ranges. PM_{10} is inferred as the sum of the two size ranges. Specific objectives of the analysis were to: (1) evaluate the frequency and severity of $PM_{2.5}$ exceedances by air basin and site throughout California; (2) determine the seasonal variation in $PM_{2.5}$ mass in different air basins; (3) determine the percentage of PM_{10} that is $PM_{2.5}$; and (4) determine the seasonal variation in the chemical composition of PM_{10} and evaluate differences among sites. Preliminary findings are summarized below.

1. $PM_{2.5}$ FRM Summary Statistics

The majority of sites in California's core $PM_{2.5}$ mass monitoring network began sampling in early 1999 and now have sufficient data for making some comparisons among the sites. The 1999 and preliminary 2000 data are summarized in Appendix C. Each site in the FRM $PM_{2.5}$ network is listed, regardless of the amount of data that has been collected. Appendix C lists the site name, AIRS site identification number, the highest 24-hour $PM_{2.5}$ measurement, the average of quarters (annual average), an indication of data completeness, the number of months represented, the number of quarters represented, and the total number of valid observations during each year. The average of quarters and the indicator of data completeness were both calculated according to the methods specified in 40 CFR Part 50, Appendix N. While two

years of $PM_{2.5}$ data have now been collected, the national $PM_{2.5}$ standards are based on three years of data and percentile averages. As a result, the available data are not yet sufficient for determining which areas are attainment and which areas are nonattainment.

The 1999 data and preliminary 2000 data show that the highest 24-hour $PM_{2.5}$ mass concentrations vary widely throughout the State. Table 9 shows the range of highest $PM_{2.5}$ concentrations for sites in California.

Table 9
Range of Highest $PM_{2.5}$ Concentrations for Sites in California
(Based on 1999 Data and Preliminary 2000 Data)

Averaging Time	Lowest High		Highest High	
	Site	Concentration	Site	Concentration
24-hour	Lakeport-Lakeport Boulevard	9.4 μg/m^3	Fresno-1st Street	160 μg/m^3
Annual Average	Echo Summit	3.8 μg/m^3	Bakersfield-5558 California Avenue	31.2 μg/m^3

In general, both the highest 24-hour and annual average $PM_{2.5}$ concentrations are found at sites in the South Coast Air Basin and San Joaquin Valley Air Basin. However, relatively high 24-hour measurements are also found in the Sacramento Valley Air Basin, San Francisco Bay Area Air Basin, and certain parts of the Mountain Counties Air Basin. Also, while the annual average concentrations at sites in these areas are substantially lower than are those in the South Coast Air Basin and San Joaquin Valley Air Basin, the annual average concentrations in 1999 at some sites in the Sacramento Valley Air Basin, as well as that for one site in 2000, exceed 15 μg/m^3, which is the level of the national annual $PM_{2.5}$ standard.

Examination of the temporal and spatial nature of $PM_{2.5}$ concentrations within each air basin highlights a mixture of isolated exceedances as well as periods of elevated $PM_{2.5}$ concentrations that are more prolonged and regional in nature. For example, an extensive regional episode in the San Joaquin Valley began on December 19, 1999 and continued through December 30, 1999. Table 10 includes monitoring sites in Central California that recorded concentrations above the 24-hour standard during this episode. As illustrated in the table, almost all $PM_{2.5}$ measurements taken during this 12-day period at the key monitoring sites in the San Joaquin Valley Air Basin exceeded the 24-hour standard. The entire Valley recorded many exceedances during this 12-day period, with some of the highest concentrations during the periods between December 22 and December 26. Concentrations varied from near the 24-hour standard of 65 μg/m^3 to as high as 134 μg/m^3 at Fresno-1st Street. Concentrations above the 24-hour standard were also reported in the San Francisco Bay Area and the

Sacramento Valley Air Basins. A similar type of episode occurred in late December 2000 and continued through early January 2001.

Table 10
Episode of Elevated $PM_{2.5}$ Concentrations in Central California from 12/19/1999 through 12/30/1999

Site Name	Number of Days Sampled		Concentrations (mg/m^3)	
	Total	Above the 24-hour Standard	High 24-hour	Average
San Joaquin Valley Air Basin				
Fresno-1st Street	10	10	134	113.1
Bakersfield-Golden State Highway	4	3	81.2	75.0
Bakersfield-5558 California Avenue	13	12	134.1	83.1
Merced-2334 M Street	4	3	108.7	85.1
Stockton-Hazelton Street	3	3	101	84.0
Modesto-14th Street	4	4	108	93.8
Visalia-N Church Street	4	4	123	90.8
San Francisco Bay Area Air Basin				
San Francisco-Arkansas Street	12	1	71.2	39.5
San Jose-4th Street	12	1	70	39.6
San Jose-Tully Road	11	2	77	39.5
Vallejo-304 Tuolumne Street	4	1	90.5	58.9
Sacramento Valley Air Basin				
Chico-Manzanita Avenue	2	1	73	44.0
Roseville-N Sunrise Blvd	2	1	79	55.5
Sacramento-Del Paso Manor	2	2	84	79.0
Sacramento-T Street	12	2	92	53.8
Sacramento-Health Dept Stockton Blvd	10	4	86	59.4

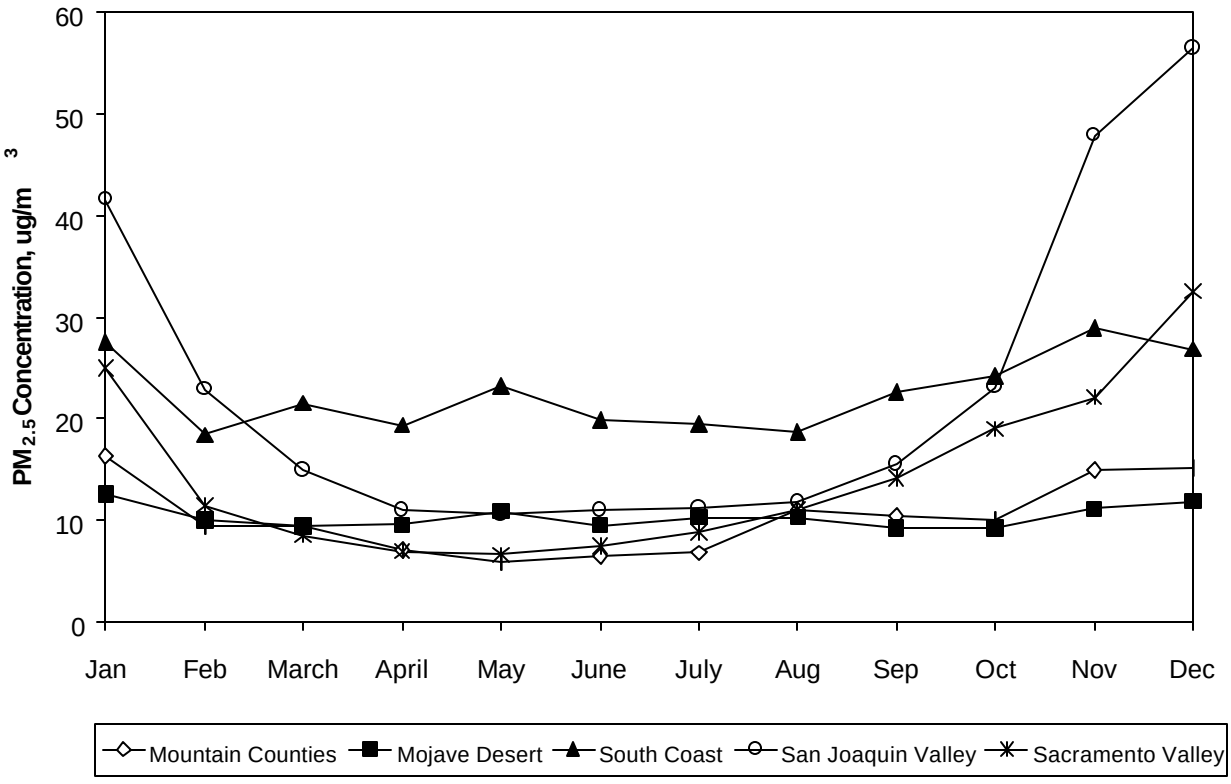
In the South Coast Air Basin, an episode on November 5, 1999, produced widespread exceedances of the 24-hour standard, with $PM_{2.5}$ concentrations ranging from 79 µg/m^3 at Burbank-W Palm Avenue and Reseda to 111 µg/m^3 at the Riverside-Rubidoux site, and 121 µg/m^3 at San Bernardino-4th Street. A more prolonged episode occurred in late September through late October 2000, with maximum concentrations reaching 120 µg/m^3 at Riverside-Rubidoux on October 20, 2000.

On average, the highest 24-hour concentrations in 1999 and 2000 occurred in November, December, and January, while the lowest concentrations occurred between March and August. Most of the Monitoring Planning Areas (MPAs) follow this seasonal pattern to some degree. The seasonality (see Figure 4) is most pronounced in the San Joaquin Valley Air Basin, where the November-December-January concentrations were on the order of 4 to 5 times greater than those for March through August.

Less pronounced seasonality following this pattern occurred in the San Francisco Bay Area Air Basin, the San Diego Air Basin, the Sacramento Valley Air Basin, the North Coast Air Basin, and the Mojave Desert Air Basin. In other MPAs, the highest concentrations occurred throughout the year, though in most cases, these "high" values were low, when compared with those MPAs that showed seasonality. The exception is the South Coast Air Basin, where fairly high values occurred throughout the year. As the $PM_{2.5}$ monitoring program continues and more data become available, more refined analyses will be possible, as well as definitive determinations of attainment and nonattainment status.

This contrast in PM concentrations is what makes the PM problem here in California so difficult and complex. The emission sources can be very diverse from one area to another. Furthermore, because of the variety of sources and the size and chemical composition of the particles, both the nature and causes of the PM problem can vary considerably from area to area. As a result, even though two areas may have similar concentrations, they may have very different PM problems. To add to the complexity, a single area may have a different type of PM problem during different times of the year. PM monitoring programs such as those required by the U.S. EPA will help in making strides toward understanding and controlling the PM problem.

Figure 4
Monthly Average PM2.5 Concentrations by Air Basin



2. Related PM Summary Statistics

Sites with both $PM_{2.5}$ and PM_{10} data were used to examine seasonal variations in the difference between $PM_{2.5}$ and PM_{10} concentrations. Similar to the seasonal variations seen in $PM_{2.5}$ mass, the difference between $PM_{2.5}$ and PM_{10} concentrations is generally smallest in the winter months in most air basins, with the $PM_{2.5}$ concentrations reaching 80 to 90 percent of PM_{10} concentrations in areas such as San Joaquin Valley and Sacramento Valley Air Basins. The lowest $PM_{2.5}$ fractions, i.e., $PM_{2.5}$ as fractions of PM_{10}, are seen in the Salton Sea and the Great Basin Valleys Air Basins, both of which often experience severe coarse particle fugitive dust events.

The difference between $PM_{2.5}$ and PM_{10} concentrations is generally greatest in the summer and early fall. During these months geological material, which is generally coarse particles, i.e., larger than $PM_{2.5}$, accounts for the major difference between $PM_{2.5}$ and PM_{10} mass. These coarse particle concentrations tend to decrease in the winter, when storms suppress fugitive dust producing activities. The South Coast provides an exception to this however, with a significant coarse fraction even into early winter.

Because of the very limited amounts of composition data available from either the $PM_{2.5}$ speciation monitors or the dichotomous samplers for 1999 and 2000, data from the PM_{10} SSI monitors were used to illustrate spatial and temporal variations in chemical composition. The species examined were nitrate, sulfate, ammonium, chloride, carbon, and other PM_{10}. The "other PM_{10}" represents the difference between the total PM_{10} mass and the sum of the measured species. This "other" fraction includes geological material, trace metals, the hydrogen and oxygen associated with organic carbon, and water. It may to a degree also represent a difference in laboratory analytical methods used to make the mass and composition determination. While these data represent PM_{10} composition, it should be noted that the majority of carbon, sulfate, nitrate, and ammonium are expected to be in the fine fraction. There are large differences in the winter months between the 1999 $PM_{2.5}$ mass data from the FRM samplers and the sum of species data from the PM_{10} samplers. This is probably largely due to the differences in the sampling methods and in the filter handling and transport.

Figures 3 through 5 display the monthly average composition at key sites in the Sacramento Valley and San Joaquin Valley Air Basins. For reference, the monthly average $PM_{2.5}$ mass for 1999 is superimposed on the graphs. Total carbon is not determined from the SSI filters at sites in the South Coast and the San Francisco Bay Area. Other data for these areas indicates that total carbon is relatively as much a contributor to particulate matter concentrations as it is for the Sacramento and San Joaquin Valleys.

At the Bakersfield-5558 California Avenue, Fresno-1st Street, and Sacramento-T Street sites, carbon and nitrate are significant contributors, with

increases in these species corresponding to the increase in $PM_{2.5}$ mass during the winter. During the peak months of November, December, and January, carbon constitutes approximately 20 to 25 percent of the PM_{10} mass, while nitrate constitutes approximately 10 to 15 percent of the PM_{10} mass. During this time of year, almost all of the particulate matter is smaller than 2.5 µm. Sulfate concentrations are much lower than nitrate concentrations during the winter high season, with somewhat higher levels during the summer months. Ammonium concentrations closely parallel those of nitrate, although at much lower concentrations, reflecting its role as the major buffering agent for this species. Chloride concentrations are low at all sites, although coastal sites record slightly higher concentrations.

In the future, we will: (1) analyze the $PM_{2.5}$ mass data through 2001 to determine compliance with the standards; (2) analyze data from the $PM_{2.5}$ speciation monitors when it becomes available; (3) conduct further analysis of selected episodes, including assessing the influence of meteorological factors, evaluating the role of transport, and examining variations in emission sources; and (4) integrate analyses of the FRM monitors with data from special studies such as the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study.

Figure 5
Monthly Average PM_{10} Chemical Composition at Bakersfield-5558 California Avenue (with $PM_{2.5}$ averages overlaid)

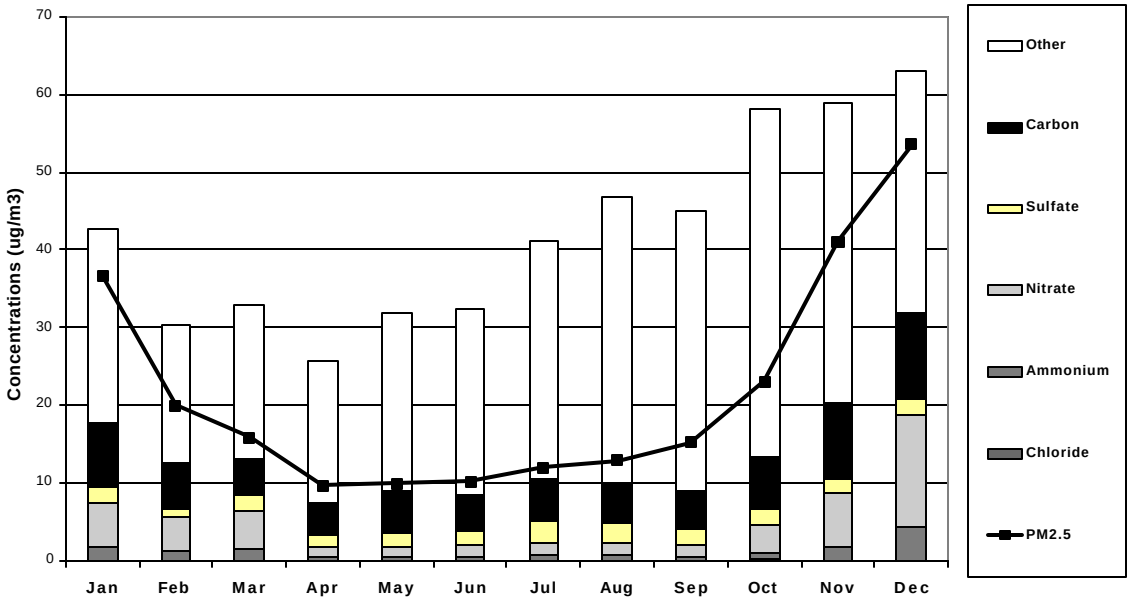


Figure 6
Monthly Average PM_{10} Chemical Composition at Fresno-1st Street
(with $PM_{2.5}$ averages overlaid)

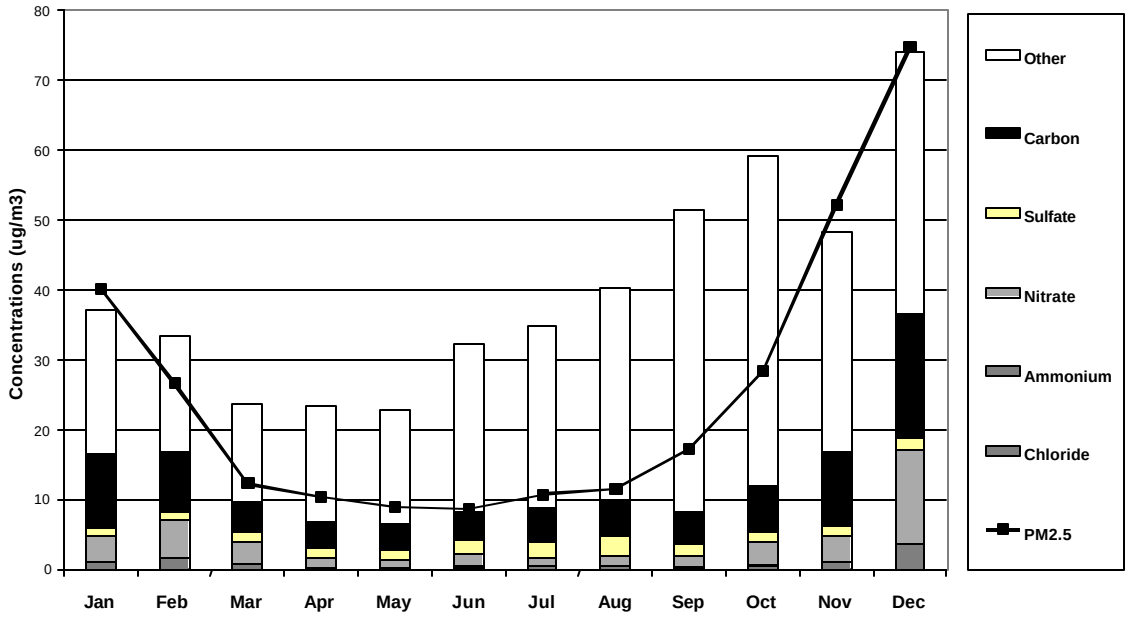
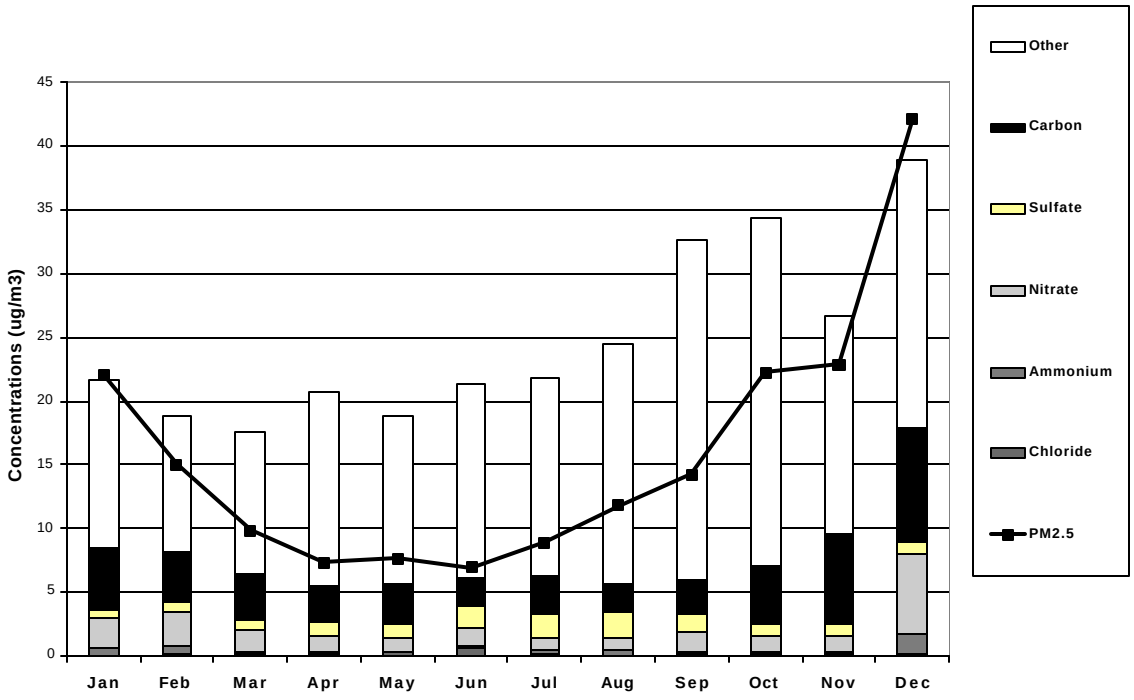


Figure 7
Monthly Average PM_{10} Chemical Composition at Sacramento-T Street
(with $PM_{2.5}$ averages overlaid)



3. Area Designations and Network Review

National Ambient Air Quality Standards apply to $PM_{2.5}$ and PM_{10} mass concentrations. The national PM standards specify the following limits:

- Twenty-four-hour average $PM_{2.5}$ not to exceed 65 $\mu g/m^3$ for a three-year average of annual 98th percentiles at any community-representative (core) site in a monitoring area.
- Three-year annual average $PM_{2.5}$ not to exceed 15 $\mu g/m^3$ from a single community-representative (core) site or the spatial average of eligible community-representative sites in a monitoring area.
- Twenty-four-hour average PM_{10} not to exceed 150 $\mu g/m^3$ more than once a year over a three-year period at any site in a monitoring area. This is calculated as an expected number of exceedances for sampling that is less than everyday.
- Three-year average of annual arithmetic means of PM_{10} concentrations not to exceed 50 $\mu g/m^3$ at any site in a monitoring area.

In contrast to the national PM standards, California has set its own State standards for PM_{10}, but not for $PM_{2.5}$. The designation criteria for the State standards specify the following limits:

- Twenty-four-hour average PM_{10} not to exceed 50 $\mu g/m^3$ during a three-year period at any site in a monitoring area, excluding exceedances affected by highly irregular or infrequent events.
- Annual geometric mean of PM_{10} concentrations not to exceed 30 $\mu g/m^3$ during a three-year period at any site in a monitoring area.

The first official national $PM_{2.5}$ area designations will take place in the year 2003, at the earliest, based on three full years of FRM data for $PM_{2.5}$. In addition, when the U.S. EPA promulgated the $PM_{2.5}$ standards, it agreed to complete its next health review of the standards prior to designating areas. That review is scheduled to be finished in 2002. The designations will be updated annually as new information becomes available. As $PM_{2.5}$ data are collected, values exceeding the national 24-hour $PM_{2.5}$ standard will be evaluated for influence by natural/exceptional events. The U.S. EPA allows $PM_{2.5}$ data that meet established natural/exceptional events guidelines to be excluded from the designation process.

California's statewide $PM_{2.5}$ network will be evaluated annually to assess the adequacy of the spatial and temporal coverage of the network. Any changes to the network, including site additions, site deletions, changes to sampling frequency, and monitor designation, will be documented.

B. Data Completeness

The primary objective of the $PM_{2.5}$ FRM mass monitoring is to identify areas where $PM_{2.5}$ concentrations exceed one or both of the national $PM_{2.5}$ standards. The nonattainment designation can have an economic impact on an area. The $PM_{2.5}$ FRM data have to be of sufficient quality and quantity in order to make defensible attainment/nonattainment decisions. The goal of the network design and review process is to ensure that monitoring resources support collecting data of adequate quality and quantity. We are including this discussion to stress the importance of having complete data at each site and to highlight potential problems that may arise when comparing data to the standards. As shown in the Appendix C, a number of sites in California do not have complete data for 1999 and/or 2000.

For the purposes of making comparisons with either the annual or 24-hour standards at a monitoring site, three years of representative monitoring data with 75 percent of the scheduled $PM_{2.5}$ samples per quarter are required. (U.S. EPA, 1997a). This requirement is quite difficult to accomplish with a one in six day sampling schedule. A monitoring site on a one in six day sampling schedule could fail the annual data completeness test by missing only 4 samples in a quarter (or less than 7 percent of the expected number of samples in a year), even if the remaining quarters have 100 percent valid data. Certain exceptions to the basic requirement for data completeness are allowed and will depend on whether you want to demonstrate that a site meets or fails a standard.

To demonstrate that a site meets either the annual or 24-hour standards, the Regional Administrator may approve using less complete data than 75 percent of the expected data for each quarter (U.S. EPA, 1999b). The Regional Administrator can consider filling in for missing scheduled sampling days for a monitoring site, if the following conditions are met:

- Have at least 50 percent of the scheduled number of samples for each quarter for all three years.
- Show that the emissions and meteorology for the substitute quarters compare to the emissions and meteorology for the quarters in question.
- Meet the standards based on the incomplete data.

Missing data may be replaced by using one of the following approaches:

- Replacing missing data with collocated $PM_{2.5}$, PM_{10}, or TSP data from the same or the nearest day (within two days before or after the scheduled sampling day). When using collocated data, you must substitute for all missing scheduled sampling days where collocated data are available, not just for selected days in that quarter.
- Replacing missing data with the maximum $PM_{2.5}$ data value from the same site across all three years for the same quarter.

There are less stringent data requirements for showing that a monitor failed an attainment test. For the 24-hour standard, years containing quarters with less than 75 percent data completeness shall be included in the computation if the annual 98th percentile value is greater than the level of the standard. This applies even if there was only one measurement in a year and that single measurement exceeded the standard. In that case, a site expected to sample everyday could be designated nonattainment for the 24-hour standard based on one sample in a year.

To demonstrate a violation of the annual $PM_{2.5}$ standard, years containing quarters with at least 11 samples shall be included in the computation if the resulting annual mean concentration is greater than the level of the standard. For a site expected to sample everyday, only 44 samples (or about 12 percent) are required to demonstrate that a site violates the annual standard. In some special circumstances, the Regional Administrator may authorize using years containing quarters with less than 11 samples in a quarter.

Our goal is to collect as complete of data as possible. Appendix C includes information on data completeness at each monitoring site in the California $PM_{2.5}$ network. The information presented in the table includes the total number of 24-hour measurements collected at the site during the year, the number of months and quarters that include at least one measurement, and an indication of the validity of the annual average value for the year. In Appendix C, we used the convention that a year that meets one of the following conditions is considered valid for calculating annual average concentrations:

- A minimum of 75 percent of the scheduled $PM_{2.5}$ samples per quarter were collected, or
- At least 11 samples per quarter were collected and the resulting annual mean concentration is greater than the level of the standard.

C. Data Distribution

Data collected as part of the $PM_{2.5}$ network are available from the U.S. EPA Aerometric Information and Retrieval System (AIRS) and the ARB air quality database (ADAM). The ARB has a very effective, customer oriented data distribution system that includes the following elements:

- **ARB Air Quality Web Site** (http://www.arb.ca.gov/aqd/aqd.htm) provides public access to ambient air quality data, maps of areas that violate the national and State standards, plans for $PM_{2.5}$ monitoring, and electronic versions of several of the reports described below.
- **Interactive data queries** of the entire California database are available from the Web site above or more directly at http://www.arb.ca.gov/adam. The user can query: 1) the top 4 values and the number of days above the standards for ozone, PM_{10}, dichot fine particles, CO, SO_2, and NO_2; 2) hourly data listings for a selected day for all gaseous pollutants; and

3) 10-week summaries of daily maximum data and other daily statistics. $PM_{2.5}$ summaries will be added by the end of 2001.

- **2000 CD-ROM** contains hourly, daily, and/or annual summary data during the 1980-1999 time period for ozone, CO, NO_x, NO, NO_2, SO_2, H_2S, THC, NMHC, CH_4, TSP, PM_{10}, $PM_{2.5}$ FRM, dichot fine and coarse particles, COH, and b_{scat}, as well as speciated TSP, PM_{10}, dichot, and hydrocarbons. Toxics data for the 1990-1999 time period are also included on the CD-ROM, as are a number of predefined annual reports which will enable the user to quickly obtain key data, including more than half of the annual Blue Sky report content and substantial portions of the *State & Local Air Monitoring Network Plan*. As with previous editions, there are two versions of the CD-ROM. The *Voyager* CD includes maps and graphs for interactive browsing of the data, while the Data CD includes compressed ASCII hourly data as well as daily and annual data in ASCII and DBF formats. Both CDs have the predefined annual reports.
- **2001 California Almanac of Emissions & Air Quality** provides key ozone, PM_{10}, and CO indicators (expected peak day concentration, design values, annual averages, and number of exceedances) for counties and air basins, from 1980 through 1999. A few indicators for NO_2 and SO_2 are also included. The report also includes preliminary year 2000 ozone data. Air quality and health risk trends of ten toxic air contaminants from 1990 through 1999 are included. An electronic version of the Almanac is available at http://www.arb.ca.gov/aqd/almanac01/almanac01.htm. The web also provides access to a supplement with information that is helpful for interpreting air quality trends in the 2001 Almanac.
- **State and Local Air Monitoring Network Plan**, February 2000 (ARB, 2000b), provides an inventory of current and historical air quality monitoring in California and Baja, Mexico, including $PM_{2.5}$ monitoring at all sites. A summary of instrument types and chemical analysis methods for criteria pollutants and maps are also included. The electronic version of the report is available on the web at http://www.arb.ca.gov/aqd/namslams/namslams.htm.

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CHAPTER 5

RELATED $PM_{2.5}$ MONITORING EFFORTS IN CALIFORNIA

In addition to the federally mandated $PM_{2.5}$ monitoring program, there are several other $PM_{2.5}$ monitoring programs in California, some of which predate the promulgation of the national $PM_{2.5}$ standards. A summary of particulate matter monitoring resources in California can be found in *The State and Local Monitoring Network Plan* (ARB, 2000b). The following sections describe ten monitoring programs that have included monitoring of fine particles. These monitoring programs are:

- U.S. EPA's PM Supersites.
- California Regional PM_{10}/$PM_{2.5}$ Air Quality Study (CRPAQS).
- California-Mexico Border Air Monitoring Program.
- California's dichotomous (dichot) sampler network.
- California Acid Deposition Monitoring Program (CADMP).
- South Coast AQMD's Particulate Technical Enhancement Programs (PTEP and TEP 2000).
- Interagency Monitoring of PROtected Visual Environments (IMPROVE) monitoring program.
- Children's Health Study.
- Children's Environmental Health Protection Program.
- Fresno Asthmatic Children's Environment Study (FACES).

In addition to these more long-term programs, many areas of the State have had special fine particle monitoring programs of limited (i.e., one year or less) duration.

A. PM Supersites

The U.S. EPA is establishing four to eight Supersites located in urban areas throughout the United States. These Supersites include an extensive array of monitoring equipment. Data collected at the Supersites will complement information from the statewide PM networks and will help in better understanding particle measurement technologies, source contributions, control strategies, and the health impacts of suspended particles. Two Supersites have been established in California - one in Fresno and one in southern California. While the ARB does provide support for the two Supersites in California, we do not have any direct control over the types of information collected or the overall program objectives. As a result, the descriptions of the Fresno and southern California PM Supersites are included for informational purposes only.

1. Fresno PM Supersite

The Fresno PM Supersite is one of two prototype Supersites established during 1999. The first phase at this site was initially set to run through March 31, 2001. However, the information collected during this phase will not be sufficient to support health studies planned for California. As a result, Phase 2 was initiated to enhance the measurements begun in Phase 1 and to accommodate the needs of simultaneous health-related studies in the Fresno area. Phase 3 will extend monitoring through March 31, 2003 and will fully integrate the Fresno Supersite measurements with those from other Supersites and with simultaneous health-related studies. The following three objectives have been established for Phase 2 and Phase 3:

1. Test and evaluate non-routine monitoring methods, with the intent of establishing their comparability with existing methods and determining their applicability to air quality planning, exposure assessment, and health impact determination.
2. Increase the knowledge base of aerosol characteristics, behavior, and sources so regulatory agencies can develop standards and strategies that protect public health.
3. Acquire measurements that can be used to evaluate relationships between aerosol properties, co-factors, and observed health end-points.

Based on these objectives, a number of hypotheses have been developed. Exploring these hypotheses will require a multi-year data set that includes large extremes in meteorology, aerosol composition, and emissions.
Six hypotheses have been set forth for Objective 1:

a) $PM_{2.5}$ and PM_{10} measurements by different methods are comparable.
b) Mass from number count equals gravimetric mass.
c) Hourly coarse particle concentrations can be reliably determined from continuous PM_{10} and $PM_{2.5}$ measurements.
d) Bioaerosols and endotoxins comprise a constant fraction of coarse particle mass.
e) Photoionization measurements are correlated with organic particle concentrations.
f) Chemiluminescent NO_2 is equivalent to true NO_2.

The five hypotheses for Objective 2 are:

a) Statistical aggregates of particle indicators for a single year deviate by less than sampling error from a three-year distribution.
b) Continuous carbon measurements differentiate carbon sources from each other.

c) Statistical indicators of source contributions do not significantly vary from year-to-year.
d) Particle size, number, surface area, and major chemical component indictors are highly correlated and are equivalent indicators of health risk.
e) $PM_{2.5}$ and PM_{10} mass concentrations were higher during drought years than during years with normal precipitation.

Finally, the Objective 3 hypotheses are:

a) Respiratory and cardiovascular distress are related to $PM_{2.5}$ concentrations and other indicators.
b) Concentration thresholds exist for air quality indicator relationships to health effects.
c) Particle characteristics have different effects on the onset and severity of short-term reductions in lung function, asthma attacks, and cardiovascular ailments.
d) Animals react differently to different particle size, surface area, chemical, and mass characteristics.
e) Particles in human lungs are similar to those in urban air.

The Objective 3 hypotheses will be tested in concurrent epidemiological, toxicological, exposure, and clinical studies that will use measurements from the Fresno PM Supersite in real time to conduct experiments and to retrospectively analyze the results.

The Fresno PM Supersite includes an extensive suite of instruments for measuring $PM_{2.5}$, PM_{10}, and coarse (PM_{10} minus $PM_{2.5}$) mass; $PM_{2.5}$ sulfate, nitrate, carbon, light absorption, and light extinction; particle size distribution; criteria pollutant gases (ozone, CO, NO_x); reactive gases (NO_y, NO_2, HNO_3, NH_3); and single particle characterization by time of flight mass spectrometry. Field sampling and laboratory analysis are applied for gaseous and particulate organic compounds (light hydrocarbons, heavy hydrocarbons, carbonyls, polycyclic aromatic hydrocarbons, and other semi-volatiles); and $PM_{2.5}$ mass, elements, ions, and carbon. Measurements common to other PM Supersites will also be taken at Fresno, including: 1) daily $PM_{2.5}$ 24-hour average mass with FRM samplers; 2) continuous hourly and five minute average $PM_{2.5}$ and PM_{10} mass with Beta Attenuation Monitors (BAM) and Tapered Element Oscillating Microbalances (TEOM); 3) daily $PM_{2.5}$ chemical speciation with an EPA speciation monitor and protocol; 4) coarse particle mass by dichotomous sampler and the difference between PM_{10} and $PM_{2.5}$ BAM and TEOM measurements; 5) coarse particle chemical composition; and 6) high sensitivity and time resolution of scalar and vector wind speed, wind direction, temperature, relative humidity, barometric pressure, and solar radiation.

In addition to the primary Fresno site, three satellite sites are operated next to a nearby heavily traveled roadway, in a nearby neighborhood that is influenced by wintertime wood burning, and in a non-urban area south of the Fresno city limits. These sites will be used for evaluating deviations in Supersite measurements owing to source proximity and isolation from urban emitters. The satellite sites are equipped with nephelometers operating continuously and with Minivol Teflon and Quartz filter samplers operating for 24-hours every sixth day to quantify mass, elemental, ion, and carbon concentrations. Data analysis activities have been defined that relate every set of measurements to the hypotheses that will be tested.

A number of results are expected from the Fresno PM Supersite monitoring program, including:

1) A long-term record of simultaneous advanced particle measurements that includes a large range of concentration levels, particle sizes, and aerosol compositions, suitable for many purposes.
2) Supportable conclusions about specific hypotheses concerning measurement method performance, causes of excessive pollution levels, and health effects.
3) Continuing linkages and collaboration among air quality scientists, toxicologists, epidemiologists, exposure specialists, and clinicians that better integrate and communicate their scientific findings.
4) A research infrastructure in California that can serve research needs after Supersite monitoring is completed.
5) Peer-reviewed, scientifically sound publications that support local, State, and national decision-making related to standard setting and pollution controls.

The ARB has committed substantial support for site operation, quality auditing, and data management. In addition, there are a number of planned and pending health studies that will use the Supersite data including: 1) Particulate Air Pollution and the Natural History of Childhood Asthma; 2) Particulate Air Pollution and the Natural History of Adult Asthma; 3) Estimating Indoor Exposure from Ambient Concentrations; 4) Health Effects of Concentrated Ambient Particles from the Central Valley of California; and 5) Relationships Among Air Quality Indicators and Medical Health Records. These projects have certain or pending support from the ARB, the Department of Energy, the U.S. EPA, and various other sources.

2. Southern California PM Supersite

The southern California PM Supersite is the second Supersite established in California. It does not comprise a single location, but rather a number of satellite locations situated throughout the southern California area. This PM Supersite began operation in January 2000 and will continue until the end of 2004. The

overall objective of the Southern California PM Supersite (SCPMS) is to conduct research and monitoring that contributes to a better understanding of the measurement, sources, size distribution, chemical composition and physical state, spatial and temporal variability, and health effects of suspended particulate matter in the Los Angeles basin. The three research objectives of the SCPMS are:

- To characterize PM, its constituents, and precursors, to better understand sources and transport affecting human exposure, and to support development of State Implementation Plans (SIPs).
- To obtain atmospheric measurements to support health studies designed to address causal factors, etiologic pathways, and mechanisms of PM-related morbidity and mortality with particular emphasis on PM source-receptor-exposure-effects pathways.
- To conduct methods testing that will enable comparisons and evaluation of different technologies for characterizing PM including evaluation of new instrumentation, sampling methods, and federal reference methods.

The proposed SCPMS activities will be integrated with the multidisciplinary research in exposure assessment, toxicology, and epidemiology of the Southern California Center for Airborne Particulate Matter (SCCAPM). The SCPMS will interact with the ARB and the South Coast Air Quality Management District (AQMD) to maximize the use and value of the PM data collected by the SCPMS and other agencies. The monitoring activities of the SCPMS will be also linked with toxicology studies in the Los Angeles basin using a mobile particulate matter concentrator facility to investigate health effects associated with exposures to ultrafine, fine, and coarse particles. These studies are funded by the SCCAPM, the Health Effects Institute, the ARB, and the National Institute of Environmental Health Sciences. The SCPMS will therefore become an invaluable resource to the major ongoing and planned PM health and modeling studies in the Los Angeles basin.

Specific projects in the category of PM characterization will provide the information that is needed to understand the relationship between PM sources and receptors, as well as providing insight into the factors that affect the spatial and temporal variability of PM characteristics. These projects are:

1) Comprehensive characterization of PM in the Los Angeles basin and correlations between particle size distribution, chemical composition, and gaseous co-pollutants.
2) Determination of the occurrence, frequency, and prevalence of $PM_{2.5}$ sub-modes in different locations of the Los Angeles basin.
3) Systematic evaluation of sampling artifacts of the FRM in measuring $PM_{2.5}$, PM_{10}, and coarse PM concentrations.

4) Study of PM formation and growth mechanisms in different locations of the Los Angeles basin.
5) Testing of the hypothesis that 2.5 µm represents a clear cutpoint between coarse and fine PM and does not depend on location or season.
6) Determination of the seasonal and spatial variation of ultrafine, accumulation, and coarse PM in the Los Angeles basin and their relation to sources. These studies will be conducted in collaboration with the South Coast AQMD and the ARB.
7) Comparison of the true $PM_{2.5}$, PM_{10}, and coarse PM concentrations with those determined gravimetrically with a FRM, and evaluation of sampling artifacts related to the loss of volatile or semi-volatile PM compounds.

A number of additional projects are proposed in the category of Support of Health Effects and Exposure Research. These projects include:

1) Detailed physico-chemical characterization of concentrated PM used in ongoing toxicity studies currently underway in the Los Angeles basin.
2) Measurement of within-community PM variability for improved dispersion models describing personal exposure indices based on traffic-based emissions for use in ongoing epidemiological investigations of chronic respiratory health effects of ambient particle matter in children.
3) Measurement of the size distribution as well as the spatial and seasonal variation of particle bound PAH, oxy-PAH, nitro-PAH, quinones, and other polar PAHs in the Los Angeles basin.
4) Determination of the contribution of volatile and semi-volatile species to total suspended $PM_{2.5}$ mass and assessment of any resulting bias in interpreting epidemiological results.
5) Measurement of aerosol oxidant partitioning in the ultrafine, accumulation, and coarse particulate matter modes.
6) Analysis of particle-bound PAH and related compounds as a function of distance from freeways.
7) Measurement of protein, allergens, and other biological constituents of urban airborne PM.

Finally, the four projects in the category of Methods Testing are:

1) Comparing the actual 24-hour averaged PM_{10} and $PM_{2.5}$ concentrations with those determined using continuous PM mass monitors, including the Scanning Mobility Particle Sizer (SMPS), Aerodynamic Particle Sizer (APS), Tapered Element Oscillating Microbalance, Continuous Ambient Mass Monitor and the Real-Time Ambient Monitor.

2) Comparing the real-time size distribution and mass concentration determined with the SMPS and APS with the 24-hour averaged mass-based size distribution measured with the MicroOrifice Uniform Deposit Impactor.
3) Development of a semi-continuous monitor for size-dependent nitrate, carbon, and sulfate measurements.
4) Evaluation and comparison of new and emerging measurement methods for single-particle analysis.

Intensive aerosol measurements that collect PM data beyond the traditional $PM_{2.5}$ mass, sulfate, and nitrate concentrations will be conducted in five discrete areas of the Los Angeles basin. These areas will be chosen to provide a wide geographical coverage, and thereby be as representative as possible of human exposures to these pollutants. A mobile Particle Instrumentation Unit, funded separately by the SCCAPM, will be deployed to these locations to conduct PM measurements. Sampling at each site will last for six months, and measurements will be repeated on a 2.5-year cycle. During the first of the six months, the Particle Instrumentation Unit will be deployed to five discrete locations downwind and one location upwind to a freeway close to the central site to determine PM characteristics as a function of distance from the freeway. A number of existing PM sites operated by the South Coast AQMD will be used as satellite sites, in addition to the five SCPMS sites, to obtain spatial PM variability in the Los Angeles basin as a function of size and composition.

B. California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS)

The California Regional $PM_{10}/PM_{2.5}$ Air Quality Study is a comprehensive, multi-year program designed to provide an improved scientific understanding of emissions, meteorology, and dynamic atmospheric processes leading to elevated PM concentrations and visibility impairment in central California (Magliano et al., 1999). As part of CRPAQS, major field monitoring campaigns were conducted from December 1999 to January 2001. Additional information about this project can be found on the web at:

http://www.arb.ca.gov/airways/ccaqs/crpaqs.htm.

The objectives of the field programs were to collect an aerometric database of specified accuracy, precision, and validity to support the following:

- Refinement of conceptual models to explain the interactions among emissions, meteorology, and ambient PM concentrations.
- Evaluation and application of source and receptor oriented models to address the effects of emission control programs.
- Assessment of the extent to which the longer-term ARB/local air district monitoring networks represent population exposure under a variety of meteorological and emissions conditions.

The field data collection efforts included four components:

1) A long-term program from December 1, 1999, through January 31, 2001.
2) A summer visibility program from July 1, 2000, through August 31, 2000.
3) A fall episodic program between October 8, 2000, and November 14, 2000.
4) A winter episodic program from December 1, 2000, to February 3, 2001.

During the winter episodic field program, additional intensive measurements were collected on 15 days forecasted to have the highest particulate matter concentrations. The field measurements were collected over a domain extending from the Pacific Ocean on the west to the Mojave Desert on the east and from the Tehachapi mountains on the south to the northern end of the Sacramento Valley. Monitoring sponsored by CRPAQS enhanced the existing long-term monitoring networks operated by the ARB and local air districts.

The CRPAQS field measurements included an upper air meteorological network of rawinsondes and radar profiler/RASS systems. The surface air quality network consisted of anchor sites with enhanced temporal resolution, measurement of precursor species and complete organic characterization, satellite sites to characterize inter- and intra-basin transport as well as near source concentrations, and a 100-meter tower to measure micrometeorological and air quality parameters. In addition, special studies were conducted during winter on the 15 intensive sampling days and included volatile organic carbon and size distribution sampling, single particle measurements, and fog chemistry.

C. California-Mexico Border Air Monitoring Program

Since 1992, the ARB has participated in cooperative air monitoring efforts in the California-Mexico border region with the U.S. EPA, the San Diego County and Imperial County APCDs, and Mexico's environmental regulatory agencies. The objective of the air monitoring program is the development of a database that will allow us to characterize the causes and severity of air pollution in the region, assess the extent of pollutant transport across the California-Mexico border, and develop strategies to improve air quality in the region.

The first station was established in 1992 in Tijuana. Since then, monitoring efforts have been expanded to include five stations in Tijuana, one in Rosarito, one in Tecate, and six in Mexicali, Mexico, two in Calexico, California, and one at Otay Mesa. The parameters currently monitored include ozone, nitrogen oxides, carbon monoxide, sulfur dioxide, particulate matter under ten microns, particulate matter under 2.5 microns, total suspended particulate, toxics, and surface meteorology (wind speed, wind direction, and ambient temperature). However, not all parameters are monitored at all sites.

Over the past year, the ARB deployed two collocated continuous $PM_{2.5}$ mass monitors at Calexico-Ethel Street and single monitors to Calexico-East and

Otay Mesa-Paseo International. The ARB plans to deploy eight $PM_{2.5}$ monitors in Tijuana, Rosarito, and Mexicali. Eight potential sites were initially identified, but one site in Mexicali has been determined as not meeting the siting criteria. Deployment of the remaining monitors is subject to further evaluation of each site's electrical supply and space availability and, in most cases, negotiations with school administrators in Mexicali and Tijuana to allow the necessary site modifications. The ARB anticipates that these monitors will be in place by the end of 2001.

D. Dichotomous (Dichot) Sampler Network

California's dichot sampler network has been in operation since 1983. Until recently, the network comprised nearly 20 sites collecting 24-hour samples (midnight to midnight) every sixth day. The dichot sampler, or virtual impactor, uses a low-volume PM_{10} inlet followed by a virtual impactor which splits the air stream in two, separating particles into two fractions: fine particles (i.e., particles with aerodynamic diameters less than 2.5 µm, or $PM_{2.5}$) and coarse particles (i.e., those having diameters of 2.5 to 10 µm). The sum of the fine and coarse fractions provides a measure of total PM_{10}. Both fractions collected by the dichot sampler are analyzed by x-ray fluorescence (XRF) spectroscopy for 30 elemental species.

With the implementation of the federally required $PM_{2.5}$ network, the ARB has phased out the dichot network. All sites in the dichot network, with one exception, have been discontinued. One site - Fresno-1st Street - remains in operation in support of the Fresno PM Supersite and health studies such as the Kaiser Central Valleys Study and the Childhood Asthma Study.

E. California Acid Deposition Monitoring Program (CADMP)

The California Acid Deposition Monitoring Program (CADMP) was established in early 1988 to determine the spatial and temporal patterns of acidic pollutant concentrations in the State. The CADMP dry-deposition network initially comprised ten samplers located in Azusa, Bakersfield, Fremont, Gasquet, Long Beach, Los Angeles, Sacramento, Santa Barbara, Sequoia National Park, and Yosemite National Park. A collocated sampler was situated at the Sacramento site until July 1993, when it was moved to Azusa. Originally, the CADMP sampler had two units designed for collection of particulate species in two size fractions (PM_{10} and $PM_{2.5}$) and for collection of acidic gases. Concentrations of dry-deposition particles and gases were measured by collecting consecutive 12-hour daytime (0600 to 1800 PST) and nighttime (1800 to 0600 PST) samples, once every sixth day.

Over the years, as the data were reviewed and the limited extent of the acid deposition problem in California became known, the number of pollutants sampled and the number of sites declined. In September 1995, the CADMP

network was reduced to five monitoring sites primarily in urban areas (i.e., Azusa, Bakersfield, Long Beach, Los Angeles, and Sacramento). The sample collection was changed from two 12-hour samples to one 24-hour sample beginning at midnight like the routine particulate matter monitoring network, and the sampling was reduced to $PM_{2.5}$ only.

The CADMP sampler data collected after September 1995 have been used for identifying trends in fine particulate mass and its species and evaluating the U.S. EPA sampling method in urban areas. The results of cross-checking the CADMP data against the Federal Reference Method (FRM) data has been used to evaluate the continuity between past CADMP $PM_{2.5}$ and future FRM $PM_{2.5}$ data in California. The continuity in quality-assured data for selected measures of mass and analyte concentration has value for evaluating long-term trends in air quality and projecting human health benefits. As the similarities between the CADMP and the recently promulgated national program for fine particulate matter became apparent, there was clearly no need to continue the CADMP effort. Consequently, ARB terminated the CADMP monitoring program in May 2000.

F. PM_{10} Technical Enhancement Programs (PTEP and TEP 2000)

In December 1994, the South Coast Air Quality Management District (AQMD) initiated a comprehensive program, the Particulate Technical Enhancement Program (PTEP), to characterize fine particulate matter in the South Coast Air Basin. To build an optimal PM database for the 1997 PM_{10} State Implementation Plan and Air Quality Management Plan (AQMP) revision, a one-year special particulate monitoring program was initiated in January 1995 as part of the PTEP program. Under this enhanced monitoring, nitric acid, ammonia, and speciated PM_{10} and $PM_{2.5}$ concentrations were measured at five stations in the South Coast Air Basin and at one background station at San Nicholas Island, located 80 miles off the southern California coast. The PM_{10} data were the first speciated particulate data collected for air quality planning purposes in the South Coast Air Basin since 1986, and the $PM_{2.5}$ data were the first such speciated data collected in this area on an annual basis. The successful one-year PTEP monitoring program was essential to the modeling analysis and development of the 1997 AQMP.

As a sequel to the PTEP program, the South Coast AQMD initiated a comprehensive program called TEP 2000 to characterize the ozone and PM problem in the South Coast Air Basin for the upcoming 2000 AQMP. Under TEP 2000, the South Coast AQMD conducted a one-year special monitoring program in the South Coast Air Basin from August 1998 through July 1999. The program included eight sites: Downtown Los Angeles, Anaheim, Diamond Bar, Fontana, Rubidoux, Ontario, Long Beach, and Costa Mesa. Samplers at these sites operated on a one-in-three day sampling schedule. Three of the sites, Downtown Los Angeles, Anaheim, and Rubidoux, sampled daily during the peak October through November period. The TEP 2000 ambient monitoring program

provided significantly more chemical speciation data than required under the U.S. EPA's new PM regulatory standards and more complete data for receptor and dispersion modeling. For a detailed description of the PM sampler, sampling location and schedule, and sample analysis for the TEP 2000 program please refer to the $PM_{2.5}$ Air Monitoring Plan for the South Coast Air Quality Management District (South Coast AQMD, 1998).

The PTEP samplers are undergoing major refurbishment at this time and are expected to be deployed over the next twelve months to four monitoring sites operated by the South Coast AQMD, Fontana-Arrow Highway, Los Angeles-North Main Street, Riverside-Rubidoux, and a new site in the Anaheim area. Two of these sites, Riverside-Rubidoux and Los Angeles-North Main Street, will operate PTEP and SASS samplers in parallel to determine relationships between the two samplers. This may allow for the future replacement of the PTEP samplers with SASS samplers by establishing continuity between the historical PTEP data and future SASS data. See Chapter 3, Section B. 1. for details.

G. Interagency Monitoring of PROtected Visual Environments (IMPROVE)

The 1977 amendments to the Federal Clean Air Act established a national goal to remedy and prevent future deterioration of visibility in Federal Class I national parks and wilderness areas. In response, federal land management agencies (National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management, and U.S. Department of Agriculture Forest Service) and the U.S. EPA coordinated a visibility program, called IMPROVE (Interagency Monitoring for PROtected Visual Environments). The IMPROVE air monitoring network began operation in 1987 and is expanding to 110 sites nationwide. At a limited number of sites, the IMPROVE program includes the characterization of haze by photography and the measurement of optical extinction with transmissometers and nephelometers. The principle monitoring method at every IMPROVE site, however, is aerosol sampling to measure the composition and concentration of fine particles that produce haze.

Aerosol monitoring in the IMPROVE network is accomplished by a combination of particle sampling and sample analysis. The sampler was designed specifically for IMPROVE. It collects four simultaneous samples: one PM_{10} sample on a Teflon filter and three $PM_{2.5}$ samples on Teflon, nylon, and quartz filters. The sampling frequency is once every third day. The PM_{10} filter is used to determine total PM_{10} mass. The $PM_{2.5}$ Teflon filter is used to measure total fine aerosol mass, individual chemical species using Proton Induced X-ray Emission and Proton Elastic Scattering Analysis, and light-absorption coefficient using the Hybrid Integrating Plate and Sphere. The nylon filter is used to measure nitrate and sulfate aerosol concentrations with Ion Chromatography. Finally, the quartz filters are analyzed for organic and elemental carbon using the Thermal Optical Reflectance method.

California IMPROVE sites support the regional haze program and complement the SLAMS $PM_{2.5}$ network by collecting air quality data in remote locations. In 1999, the IMPROVE Steering Committee began expanding the nationwide network. In California, nine new sites were proposed. Of these nine new sites, all were installed from late 1999 through early 2001 with the exception of the Conway Summit site proposed to represent air quality in the Hoover, and northern portion of the John Muir, wilderness areas. Installation of the Conway Summit site is pending the spring snow melt. With its completion, there will be eighteen IMPROVE sites operating in the remote areas of the state. Table 11 provides an update of the IMPROVE Network Expansion in California as of May 1, 2001. The sites are listed from north to south by Class I Areas.

Table 11
Status of IMPROVE Network Sites in California

IMPROVE Site/Class I Areas	Location and Status
Redwood National Park	Operating in Redwood National Park since 1988.
Marble Mountain - Yolla Bolly	New site installed at Trinity Conservation Camp northwest of Lake Shasta.
Lava Beds - South Warner	New site installed at Lava Beds National Monument.
Lassen - Thousand Lakes - Caribou	Operating in Lassen Volcanic National Park since 1988.
Point Reyes	Operating in Point Reyes National Seashore since 1988. ARB operating $PM_{2.5}$ BAM and surface Met since December 1, 2000.
Pinnacles - Ventana	Operating in Pinnacles National Monument since 1988.
D.L. Bliss - Desolation - Mokelumne	Operating in D.L.Bliss State Park since 1990.
Kaiser - Ansel Adams	New site installed February 2000 at Chinese Peak (Sierra Summit Ski Area).
Emigrant - Yosemite	Operating in Yosemite National Park since 1988.
Hoover - "North" John Muir	New site at Conway Summit radio facility pending spring snow melt.
Kings Canyon - Sequoia - "South" John Muir	Operating in Sequoia National Park since 1992.
Dome Land	New site installed at Bureau of Land Management South Fork Fire Station near Onyx, California.
Death Valley	Operated by the National Park Service since 1993 as an "IMPROVE Protocol" Site, following IMPROVE procedures but outside the purview of the IMPROVE Steering Committee.
San Rafael	New site installed at the U.S. Department of Agriculture Forest Service Figueroa Mountain Fire Station. ARB permit pending to install $PM_{2.5}$ BAM and surface Met.
San Gabriel - Cucamonga	New site installed at U.S. Department of Agriculture Forest Service Vetter Mountain Fire Lookout.
San Gorgonio - San Jacinto	Operating in San Gorgonio since 1988.
Joshua Tree	New site installed at Joshua Tree National Park.
Agua Tibia	New site Installed near Dripping Springs Campground.

The ARB analyzed annual average $PM_{2.5}$ concentrations at eleven of the California IMPROVE sites. Annual $PM_{2.5}$ concentrations varied from as little as 2.5 µg/m^3 at Lassen and Redwood National Parks to as high as 10 µg/m^3 at San Gorgonio Wilderness, which is downwind of urban Los Angeles. The analysis showed that low secondary aerosol and elemental carbon contributions are characteristic of the cleaner sites, while greater organic carbon fractions are seen at the sites with higher concentrations.

H. Children's Health Study

The Children's Health Study (*"Epidemiologic Investigation to Identify Chronic Health Effects of Ambient Air Pollutants in Southern California"*) is a three-phase, 10-year study to determine whether long-term exposure to air pollution in southern California is responsible for chronic respiratory effects in children (Peters, et al., 1994; Lurmann, et al., 1994). One of the objectives of the study is to characterize the population's exposure to air pollution at the community and personal levels. Based on student populations and pollutant levels, 12 communities were chosen for monitoring. They are Atascadero, Santa Maria, Lompoc, Glendora (substituted for San Dimas in 1996), Upland, Long Beach, Mira Loma, Riverside, Lake Elsinore, Lake Arrowhead, Lancaster, and Alpine. The air pollutants measured at all communities are ozone, nitrogen dioxide, nitric acid, hydrochloric acid, formic acid, acetic acid, PM_{l0} mass, $PM_{2.5}$ mass, chloride, nitrate, sulfate, and ammonium. The communities were chosen to provide a wide diversity of the pollutants of interest, ranging from low levels of all pollutants (Atascadero, Santa Maria, and Lompoc) to high levels of all pollutants (Glendora and Upland), and including communities with mixed profiles (such as Lake Arrowhead, with high ozone and low nitrogen dioxide, acids, and PM_{10} and $PM_{2.5}$ mass).

I. Children's Environmental Health Protection Program

Through the Children's Environmental Health Protection Program, California has established special air monitoring sites to evaluate the adequacy of California's current air pollution monitoring network to determine children's exposure to air pollutants. The law creating this program, Senate Bill 25 (Chapter 731, Statutes of 1999), was written by Senator Martha Escutia and signed by Governor Davis. Under the law, the ARB is required to do the following:

- Review the State's ambient air quality standards, in conjunction with the Office of Environmental Health Hazard Assessment, to determine whether the standards adequately protect the health of the public, including children, and revise those standards found to be inadequate.
- Expand monitoring of air pollutants to assess the monitoring network's ability to measure children's exposure to air pollution.
- Identify and control toxic air contaminants to which children may be especially sensitive.

Air monitoring for this study is being conducted in six communities statewide including Barrio Logan in San Diego; Boyle Heights and Wilmington in Los Angeles; Fruitvale and Crockett in the Bay Area; and Fresno in the Central Valley. These sites were chosen for monitoring based upon proximity to major emission sources including industrial facilities and mobile emission sources. Monitored air pollutants include: criteria pollutants (including $PM_{2.5}$ mass), NMHC, air toxic gases including formaldehyde, benzene, and 1,3 butadiene, air toxic particulate including nickel, hexavalent chromium, and diesel particulate. Monitoring began at most sites between October 1999 and August 2001, and will continue for at least one year at each site.

J. Fresno Asthmatic Children's Environment Study (FACES)

The FACES study (*"Responses to Short-term Fluctuations in Particulate Air Pollution in Asthmatic Children: Implications for Asthma Natural History")* is a 5 year study to determine how various environmental factors influence the way a child's asthma progresses over time. In November 2000, the recruitment of 450 asthmatic children aged 6 - 10 years started in the Fresno/Clovis area. The air pollutants of interest include:

- Criteria pollutants: ozone, nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), PM_{10} mass, and $PM_{2.5}$ mass.
- Particulate matter composition: $PM_{2.5}$ species (nitrate, sulfate, and elemental and organic carbon), PM_{10} elemental species, and ultrafine particle number concentration.
- Other pollutants: polycyclic aromatic hydrocarbons (PAH's) and bioaerosols (pollens, spores, and endotoxins).

The study will consider outdoor, indoor, and personal exposures thought to trigger asthma attacks or symptoms. The pollutants will be monitored at the Fresno Supersite and two mobile monitoring stations. The children's respiratory health will be evaluated at the time of enrollment and every 6 months thereafter. Each child will also participate in up to ten 2-week intensive follow-up periods, when daily measures of health will be collected, in order to evaluate the cumulative effect of repeated short-term responses to daily environmental exposures.

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APPENDIX A

$PM_{2.5}$ MASS MONITORING FOR COMPARISON TO THE STANDARDS

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Appendix A
$PM_{2.5}$ Mass Monitoring for Comparison to the Standards

SQ Federal Reference Method (FRM) $PM_{2.5}$ sequential sampler.
Col SQ Collocated $PM_{2.5}$ FRM sequential samplers.
SCH $PM_{2.5}$ FRM single-channel sampler.
Col SCH Collocated $PM_{2.5}$ FRM single-channel samplers.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Type of Monitor	Date of 1st Valid Sample	Sampling Schedule	Supporting Lab
Bay Area AQMD						
Concord-2975 Treat Blvd	060130002	BA	Col SQ	3/19/99	Everyday (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
Fremont-Chapel Way	060011001	BA	SQ	1/27/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
Livermore-793 Rincon Avenue	060010007	BA	SQ	12/2/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
Redwood City	060811001	BA	Col SQ	2/26/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
San Francisco-Arkansas Street	060750005	BA	SQ	2/17/99	Everyday (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
San Jose-4th Street	060850004	BA	SQ	3/1/99	Everyday (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
San Jose-Tully Road	060852003	BA	SQ	3/4/99	Everyday (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
Santa Rosa-5th Street	060970003	BA	SQ	1/2499	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
Vallejo-304 Tuolumne Street	060950004	BA	SQ	3/10/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	BA
Coachella Valley						
Indio-Jackson Street	060652002	SC	Col SQ	2/8/99	1 in 3 day	SC
Palm Springs-Fire Station	060655001	SC	SQ	1/1/00	1 in 3 day	SC
Great Basin Unified APCD						
Keeler-Cerro Gordo Road	060271003	GBU	Col SQ	1/3/99	1 in 3 day	GBU
Mammoth Lakes-Gateway HC	060510001	GBU	SQ	11/20/00	1 in 3 day	GBU
Imperial County APCD						
Brawley-Main Street	060250003	IMP	SQ	1/3/99	1 in 3 day	SD
Calexico-Ethel Street	060250005	ARB	Col SQ	1/3/99	1 in 3 day	SD
El Centro-9th Street	060251003	IMP	SQ	1/3/99	1 in 3 day	SD
Lake County Air Basin						
Lakeport-Lakeport Blvd	060333001	LAK	SCH	1/6/99	1 in 6 day	BA
Lake Tahoe Air Basin						
Echo Summit	060170012	ARB	SQ	1/1/00	1 in 3 day	ARB
South Lake Tahoe-Sandy Way	060170011	ARB	Col SCH	1/12/99	1 in 6 day	ARB
Mojave Desert Air Basin						
Lancaster-W Pondera Street	060379002	MD	SQ	1/3/99	1 in 3 day	MD
Mojave-923 Poole Street	060290011	ARB	SQ	1/3/99	1 in 3 day	SD
Ridgecrest-Las Flores Avenue	060290012	KER	SQ	6/26/99	1 in 3 day	SD
Victorville-Armagosa Road	060710014	MD	Col SQ	1/3/99	1 in 3 day	MD

Appendix A (continued)
$PM_{2.5}$ Mass Monitoring for Comparison to the Standards

SQ Federal Reference Method (FRM) $PM_{2.5}$ sequential sampler.
Col SQ Collocated $PM_{2.5}$ FRM sequential samplers.
SCH $PM_{2.5}$ FRM single-channel sampler.
Col SCH Collocated $PM_{2.5}$ FRM single-channel samplers.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Type of Monitor	Date of 1st Valid Sample	Sampling Schedule	Supporting Lab
Monterey Bay Unified APCD						
Salinas #3[1]	060531003	MBU	SQ	1/4/00	1 in 6 day	BA
Santa Cruz-2544 Soquel Avenue	060870007	MBU	Col SQ	2/23/99	1 in 6 day	BA
Mountain Counties Air Basin						
Grass Valley-Litton Building	060570005	NSI	SCH	1/6/99	1 in 6 day	ARB
Portola-161 Nevada Street[2]	060631009	NSI	SQ	5/21/00	1 in 3 day	ARB
Quincy-N Church Street	060631006	NSI	SQ	3/28/99	1 in 3 day	ARB
San Andreas-Gold Strike Road	060090001	ARB	SCH	1/6/99	1 in 6 day	ARB
Truckee-Fire Station	060571001	NSI	Col SQ	3/31/99	1 in 3 day	ARB
North Coast Air Basin						
Eureka-Health Dept 6th and I Street	060231002	NCU	SCH	1/8/99	1 in 6 day	BA
Ukiah-County Library	060450006	MEN	Col SCH	1/7/99	1 in 6 day	BA
Northeast Plateau Air Basin						
Alturas-W 4th Street	060490001	SIS	SCH	1/18/99	1 in 6 day	ARB
Sacramento Valley Air Basin						
Chico-Manzanita Avenue	060070002	ARB	SCH	12/19/98	1 in 6 day	ARB
Colusa-Sunrise Blvd	060111002	ARB	SQ	12/16/98	1 in 3 day	ARB
Redding-Health Dept Roof	060890004	SHA	SCH	12/19/98	1 in 6 day	ARB
Roseville-N Sunrise Blvd	060610006	ARB	SCH	12/31/98	1 in 6 day	ARB
Sacramento-Del Paso Manor	060670006	SAC	Col SQ	1/3/99	Everyday (Oct-Mar) 1 in 3 day (Apr-Sep)	ARB
Sacramento-Health Dept Stockton Blvd	060674001	SAC	SQ	2/2/99	Everyday (Oct-Mar) 1 in 3 day (Apr-Sep)	ARB
Sacramento-T Street	060670010	ARB	SQ	12/13/98	Everyday	ARB
Woodland-Gibson Road	061131003	YS	SQ	1/9/99	1 in 3 day	ARB
Yuba City-Almond Street	061010003	ARB	Col SCH	12/19/98	1 in 6 day	ARB
San Diego County APCD						
Chula Vista	060730001	SD	SQ	1/3/99	1 in 3 day	SD
El Cajon-Redwood Avenue	060730003	SD	SQ	1/1/99	Everyday	SD
Escondido-E Valley Parkway	060731002	SD	SQ	1/1/99	Everyday	SD
San Diego-12th Avenue	060731007	SD	SQ	1/1/99	Everyday	SD
San Diego-Overland Avenue	060730006	SD	Col SQ	1/3/99	1 in 3 day	SD

[1] Salinas #3 replaced Salinas-Natividad Road #2, which operated from 2/17/99 through 2/28/00.
[2] Portola-161 Nevada Street replaced Portola-Commercial Street, which operated from 3/28/99 through 2/9/00.

Appendix A (continued)
$PM_{2.5}$ Mass Monitoring for Comparison to the Standards

SQ Federal Reference Method (FRM) $PM_{2.5}$ sequential sampler.
Col SQ Collocated $PM_{2.5}$ FRM sequential samplers.
SCH $PM_{2.5}$ FRM single-channel sampler.
Col SCH Collocated $PM_{2.5}$ FRM single-channel samplers.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Type of Monitor	Date of 1st Valid Sample	Sampling Schedule	Supporting Lab
San Joaquin Valley Unified APCD						
Bakersfield-5558 California Avenue	060290014	ARB	Col SQ	1/3/99	Everyday	VEN
Bakersfield-1120 Golden State Highway	060290010	ARB	SQ	1/3/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	VEN
Bakersfield-410 E Planz Road	060290016	ARB	SQ	2/18/00	1 in 3 day	VEN
Clovis-N Villa Avenue	060195001	SJV	SQ	1/3/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	VEN
Corcoran-Patterson Avenue	060310004	SJV	SQ	1/3/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	VEN
Fresno-1st Street	060190008	ARB	Col SQ	1/3/99	Everyday	ARB
Fresno-Pacific College	060192025	SJV	SQ	1/13/00	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	VEN
Merced-M Street	060472510	SJV	SQ	4/12/99	1 in 3 day (Oct-Mar) 1 in 6 day (Apr-Sep)	VEN
Modesto-814 14th Street	060990005	ARB	SQ	1/3/99	1 in 3 day	ARB
Stockton-Hazelton Street	060771002	ARB	SQ	1/3/99	1 in 3 day	ARB
Visalia-N Church Street	061072002	ARB	SQ	1/3/99	1 in 3 day	ARB
San Luis Obispo County APCD						
Atascadero-Lewis Avenue	060798001	SLO	Col SCH	1/6/99	1 in 6 day	VEN
San Luis Obispo-Marsh Street	060792002	ARB	SCH	1/6/99	1 in 6 day	VEN
Santa Barbara County APCD						
Santa Barbara-W Carillo Street	060830010	ARB	SCH	3/1/99	1 in 6 day	VEN
Santa Maria-Broadway	060831007	ARB	SCH	8/16/99	1 in 6 day	VEN
South Coast Air Basin						
Anaheim-Harbor Blvd[3]	060590001	SC	Col SQ	1/3/99	Everyday	SC
Azusa	060370002	SC	SQ	1/4/99	Everyday	SC
Big Bear City-501 W Valley Blvd	060718001	SC	SQ	2/8/99	1 in 6 day	SC
Burbank-W Palm Avenue	060371002	SC	SQ	1/21/99	1 in 3 day	SC
Fontana-Arrow Highway	060712002	SC	Col SQ	1/3/99	1 in 3 day	SC
Los Angeles-North Main Street	060371103	SC	Col SQ	1/22/99	Everyday	SC
Lynwood	060371301	SC	SQ	1/3/99	1 in 3 day	SC
Mission Viejo-26081 Via Pera	060592022	SC	SQ	6/17/99	1 in 3 day	SC
North Long Beach[4]	060374002	SC	SQ	1/3/99	Everyday	SC
Ontario-1408 Francis Street	060710025	SC	SQ	1/3/99	1 in 3 day	SC
Pasadena-S Wilson Avenue	060372005	SC	SQ	3/4/99	1 in 3 day	SC
Pico Rivera	060371601	SC	SQ	1/15/99	1 in 3 day	SC
Reseda	060371201	SC	SQ	1/24/99	1 in 3 day	SC
Riverside-Magnolia	060651003	SC	SQ	1/6/99	1 in 3 day	SC
Riverside-Rubidoux	060658001	SC	Col SQ	1/3/99	Everyday	SC
San Bernardino-4th Street	060719004	SC	SQ	1/3/99	1 in 3 day	SC

[3] The South Coast AQMD is relocating the Anaheim-Harbor Blvd site to a new site in the Anaheim area. Until a permanent Anaheim monitoring site begins operation, the collocated sampler will be located at the Azusa site.

[4] The South Coast AQMD plans to move the $PM_{2.5}$ FRM sampler from the North Long Beach site to a new site in the South Long Beach area, because special particulate studies conducted recently indicate that area better represents the expected maximum concentrations experienced in the greater Long Beach area.

Appendix A (continued)
$PM_{2.5}$ Mass Monitoring for Comparison to the Standards

SQ Federal Reference Method (FRM) $PM_{2.5}$ sequential sampler.
Col SQ Collocated $PM_{2.5}$ FRM sequential samplers.
SCH $PM_{2.5}$ FRM single-channel sampler.
Col SCH Collocated $PM_{2.5}$ FRM single-channel samplers.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Type of Monitor	Date of 1st Valid Sample	Sampling Schedule	Supporting Lab
Ventura County APCD						
El Rio-Rio Mesa School #2	061113001	VEN	SQ	1/9/99	1 in 3 day	VEN
Piru-Pacific Avenue	061110009	VEN	SQ	11/23/00	1 in 3 day	VEN
Simi Valley-Cochran Street	061112002	VEN	SQ	1/3/99	1 in 3 day	VEN
Thousand Oaks-Moorpark Road	061110007	VEN	Col SQ	1/3/99	1 in 3 day	VEN

***Key to Operating Agency Codes:**

ARB	Air Resources Board
BA	Bay Area Air Quality Management District
GBU	Great Basin Valleys Unified Air Pollution Control District
IMP	Imperial County Air Pollution Control District
KER	Kern County Air Pollution Control District
LAK	Lake County Air Quality Management District
MBU	Monterey Bay Unified Air Pollution Control District
MD	Mojave Desert Air Quality Management District
MEN	Mendocino County Air Quality Management District
NCU	North Coast Unified Air Quality Management District
NSI	Northern Sierra Air Quality Management District
SAC	Sacramento Metropolitan Air Quality Management District
SC	South Coast Air Quality Management District
SD	San Diego County Air Pollution Control District
SHA	Shasta County Air Quality Management District
SIS	Siskiyou County Air Pollution Control District
SJV	San Joaquin Valley Unified Air Pollution Control District
SLO	San Luis Obispo County Air Pollution Control District
VEN	Ventura County Air Pollution Control District
YS	Yolo-Solano County Air Quality Management District

APPENDIX B

EXISTING AND PLANNED $PM_{2.5}$ MONITORING NETWORK IN CALIFORNIA

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Appendix B
Existing and Planned $PM_{2.5}$ Monitoring Network in California

FRM: Federal Reference Method (FRM) $PM_{2.5}$ sequential or single-channel mass sampler.

CMM: $PM_{2.5}$ continuous mass monitor. Most, if not all, of these are beta-attenuation monitors (BAMs).

Speciation: 24-hour (filter-based) and 1-Hour (continuous) speciation monitors. All 1-hour speciation monitors are planned. Most of the 24-hour speciation monitors are Spiral Aerosol Speciation Samplers (SASS).

Bold Monitor is designated a National Air Monitoring Station (NAMS) monitor.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Mass		Speciation	
			FRM	CMM	24-Hour	Continuous
Bay Area AQMD						
Concord-2975 Treat Blvd	060130002	BA	Deployed (Collocated)			
Fremont-Chapel Way	060011001	BA	Deployed			
Livermore-793 Rincon Avenue	060010007	BA	Deployed	Deployed		
Oakland area[1]		BA		Planned		
Patterson Pass[2]		BA		Planned		
Point Reyes		IMPROVE		Deployed		
Redwood City	060811001	BA	Deployed (Collocated)			
San Francisco-Arkansas Street	060750005	BA	**Deployed**	Deployed		
San Jose-4th Street	060850004	BA	**Deployed**	Deployed	**Deployed**	Aethelometer
San Jose-Tully Road	060852003	BA	Deployed			
Santa Rosa-5th Street	060970003	BA	Deployed			
Vallejo-304 Tuolumne Street	060950004	BA	**Deployed**			
Coachella Valley						
Indio-Jackson Street	060652002	SC	Deployed (Collocated)	Deployed		
Palm Springs-Fire Station	060655001	SC	Deployed			
Great Basin Unified APCD						
Keeler-Cerro Gordo Road	060271003	GBU	Deployed (Collocated)			
Mammoth Lakes-Gateway HC	060510001	GBU	Deployed[3]			
Imperial County APCD						
Brawley-Main Street	060250003	IMP	Deployed			
Calexico-East	060250006	ARB		Deployed		
Calexico-Ethel Street	060250005	ARB	**Deployed** (Collocated)	Deployed (Collocated)	Planned	
El Centro-9th Street	060251003	IMP	Deployed			
Lake County Air Basin						
Lakeport-Lakeport Blvd	060333001	LAK	Deployed			

[1] The ARB and the Bay Area AQMD will coordinate on the selection of a site in west Oakland.

[2] This site will replace the Altamont Pass site that was in operation during CRPAQS.

[3] Mammoth Lakes, Quincy, and Portola are all potentially smoke-impacted and we have proposed that one should be designated as a NAMS. Before a decision can be made, the involved agencies will need to coordinate on this, and more data will be needed from the recently opened Mammoth Lakes site.

Appendix B (continued)
Existing and Planned $PM_{2.5}$ Monitoring Network in California

FRM: Federal Reference Method (FRM) $PM_{2.5}$ sequential or single-channel mass sampler.

CMM: $PM_{2.5}$ continuous mass monitor. Most, if not all, of these are beta-attenuation monitors (BAMs).

Speciation: 24-hour (filter-based) and 1-Hour (continuous) speciation monitors. All 1-hour speciation monitors are planned. Most of the 24-hour speciation monitors are Spiral Aerosol Speciation Samplers (SASS).

Bold Monitor is designated a National Air Monitoring Station (NAMS) monitor.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Mass		Speciation	
			FRM	CMM	24-Hour	Continuous
Lake Tahoe Air Basin						
Echo Summit	060170012	ARB	Deployed			
South Lake Tahoe-Sandy Way	060170011	ARB	Deployed (Collocated)			
Mojave Desert Air Basin [4]						
Lancaster-W Pondera Street	060379002	MD	Deployed			
Mojave-923 Poole Street	060290011	ARB	Deployed			
Ridgecrest-Las Flores Avenue	060290012	KER	Deployed			
Victorville-Armagosa Road	060710014	MD	Deployed (Collocated)			
Monterey Bay Unified APCD						
Salinas #3	060531003	MBU	Deployed	Deployed		
Santa Cruz-2544 Soquel Avenue	060870007	MBU	Deployed (Collocated)			
Mountain Counties Air Basin						
Grass Valley-Litton Building	060570005	NSI	Deployed			
Portola-161 Nevada Street	060631009	NSI	Deployed[3]	Planned	Planned	
Quincy-N Church Street	060631006	NSI	Deployed[3]			
San Andreas-Gold Strike Road	060090001	ARB	Deployed			
Truckee-Fire Station	060571001	NSI	Deployed (Collocated)			
Yosemite Village	060431001	tbd		Planned		
North Coast Air Basin						
Eureka-Health Dept 6th and I Street	060231002	NCU	Deployed			
Ukiah-County Library	060450006	MEN	Deployed (Collocated)			
Northeast Plateau Air Basin						
Alturas-W 4th Street	060490001	SIS	Deployed			

[4] This table does not include a Special Purpose Monitoring site located at Marine Corps Air Ground Combat Center, Twentynine Palms. The site will include continuous and gravimetric $PM_{2.5}$ monitors. The site needs to be inspected and approved by the ARB's Monitoring and Laboratory Division before it is considered part of the routine network.

Appendix B (continued)
Existing and Planned $PM_{2.5}$ Monitoring Network in California

FRM: Federal Reference Method (FRM) $PM_{2.5}$ sequential or single-channel mass sampler.

CMM: $PM_{2.5}$ continuous mass monitor. Most, if not all, of these are beta-attenuation monitors (BAMs).

Speciation: 24-hour (filter-based) and 1-Hour (continuous) speciation monitors. All 1-hour speciation monitors are planned. Most of the 24-hour speciation monitors are Spiral Aerosol Speciation Samplers (SASS).

Bold Monitor is designated a National Air Monitoring Station (NAMS) monitor.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Mass		Speciation	
			FRM	CMM	24-Hour	Continuous
Sacramento Valley Air Basin						
Chico-Manzanita Avenue	060070002	ARB	Deployed	Planned (Collocated)	Planned	Aethelometer[5]
Colusa-Sunrise Blvd	060111002	ARB	Deployed			
Elk Grove-Bruceville Road	060670011	SAC		Deployed		
Folsom-Natoma Street	060670012	SAC		Planned		
Gridley	060074001	ARB		Deployed		
Redding-Health Dept Roof	060890004	SHA	Deployed			
Roseville-N Sunrise Blvd	060610006	ARB	Deployed			
Sacramento-Del Paso Manor	060670006	SAC	**Deployed** (Collocated)	Deployed	**Deployed**	Aethelometer, Nitrate
Sacramento-Health Dept Stockton Blvd	060674001	SAC	Deployed			
Sacramento-T Street	060670010	ARB	Deployed	Deployed	Planned	
Woodland-Gibson Road	061131003	YS	Deployed			
Yuba City-Almond Street	061010003	ARB	Deployed (Collocated)			
San Diego County APCD						
Chula Vista	060730001	SD	Deployed			
El Cajon-Redwood Avenue	060730003	SD	**Deployed**		**Deployed**	
Escondido-E Valley Parkway	060731002	SD	Deployed	Deployed	Planned	
Otay Mesa-Paseo International	060732007			Deployed		
San Diego-12th Avenue	060731007	SD	**Deployed**	Planned[6]		
San Diego-Overland Avenue	060730006	SD	Deployed (Collocated)			

[5] This site will receive a monitor only if sufficient monitors are available.

[6] There may not be adequate space at the site to deploy this monitor. The air district and ARB are discussing the situation.

Appendix B (continued)
Existing and Planned $PM_{2.5}$ Monitoring Network in California

FRM: Federal Reference Method (FRM) $PM_{2.5}$ sequential or single-channel mass sampler.

CMM: $PM_{2.5}$ continuous mass monitor. Most, if not all, of these are beta-attenuation monitors (BAMs).

Speciation: 24-hour (filter-based) and 1-Hour (continuous) speciation monitors. All 1-hour speciation monitors are planned. Most of the 24-hour speciation monitors are Spiral Aerosol Speciation Samplers (SASS).

Bold Monitor is designated a National Air Monitoring Station (NAMS) monitor.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Mass		Speciation	
			FRM	CMM	24-Hour	Continuous
San Joaquin Valley Unified APCD						
Bakersfield-5558 California Avenue	060290014	ARB	**Deployed** (Collocated)	Deployed (Collocated planned)	**Deployed**	Aethelometer, Nitrate, Sulfate
Bakersfield-1120 Golden State Highway	060290010	ARB	Deployed			
Bakersfield-410 E Planz Road	060290016	ARB	Deployed			
Clovis-N Villa Avenue	060195001	SJV	Deployed			
Corcoran-Patterson Avenue	060310004	SJV	Deployed			Aethelometer, Nitrate
Fresno-1st Street	060190008	ARB	**Deployed** (Collocated)	Deployed	**Deployed**	Aethelometer (2), Carbon, Nitrate (2), Sulfate
Fresno-Pacific College	060192025	SJV	Deployed			
Merced-M Street	060472510	SJV	Deployed			
Modesto-814 14th Street	060990005	ARB	**Deployed**	Planned	Planned	Aethelometer, Nitrate
Stockton-Hazelton Street	060771002	ARB	**Deployed**			
Oakhurst		SJV				Aethelometer
Tracy		SJV		Planned		
Visalia-N Church Street	061072002	ARB	**Deployed**	Planned	Planned	Aethelometer, Nitrate
San Luis Obispo County APCD						
Atascadero-Lewis Avenue	060798001	SLO	Deployed (Collocated)			
San Luis Obispo-Marsh Street	060792002	ARB	Deployed			
Santa Barbara County APCD						
Santa Barbara-W Carillo Street	060830010	ARB	Deployed			
Santa Maria-Broadway	060831007	ARB	Deployed			
San Rafael Wilderness		IMPROVE		Planned		

Appendix B (continued)
Existing and Planned $PM_{2.5}$ Monitoring Network in California

FRM: Federal Reference Method (FRM) $PM_{2.5}$ sequential or single-channel mass sampler.

CMM: $PM_{2.5}$ continuous mass monitor. Most, if not all, of these are beta-attenuation monitors (BAMs).

Speciation: 24-hour (filter-based) and 1-Hour (continuous) speciation monitors. All 1-hour speciation monitors are planned. Most of the 24-hour speciation monitors are Spiral Aerosol Speciation Samplers (SASS).

Bold Monitor is designated a National Air Monitoring Station (NAMS) monitor.

Site Name (by MPA)	AIRS Site ID	Operating Agency*	Mass		Speciation	
			FRM	CMM	24-Hour	Continuous
South Coast Air Basin						
Anaheim area[7]	060590001	SC	**Deployed** (Collocated)	Planned	PTEP Planned[8]	Aethelometer, Nitrate
Azusa	060370002	SC	**Deployed**	Planned		Nitrate[5]
Banning-South Hathaway Street	060650012	SC		Deployed		
Big Bear City-501 W Valley Blvd	060718001	SC	Deployed			
Burbank-W Palm Avenue	060371002	SC	**Deployed**	Deployed		Nitrate[5]
Fontana-Arrow Highway	060712002	SC	Deployed (Collocated)		PTEP Planned[8]	Nitrate[5]
Los Angeles-North Main Street	060371103	SC	**Deployed** (Collocated)	Deployed	PTEP and SASS Planned[8]	Aethelometer[5] Nitrate[5]
Lynwood	060371301	SC	Deployed			
Mission Viejo-26081 Via Pera	060592022	SC	Deployed			
North Long Beach[9]	060374002	SC	**Deployed**[9]			
Ontario-1408 Francis Street	060710025	SC	Deployed			
Pasadena-S Wilson Avenue	060372005	SC	Deployed			
Pico Rivera	060371601	SC	Deployed			
Reseda	060371201	SC	Deployed			
Riverside-Magnolia	060651003	SC	Deployed			
Riverside-Rubidoux	060658001	SC	**Deployed** (Collocated)	Deployed (Collocated planned)	**SASS** (2) **Deployed** PTEP Planned[8]	Aethelometer, Nitrate
San Bernardino-4th Street	060719004	SC	Deployed			
South Long Beach area[9]	New Site	SC	**Planned**[9]	Planned[9]		
Ventura County APCD						
El Rio-Rio Mesa School #2	061113001	VEN	Deployed			
Piru-Pacific Avenue	061110004	VEN	Deployed			
San Nicolas Island				Deployed		
Simi Valley-Cochran Street	061112002	VEN	**Deployed**	Planned	**Planned**	
Thousand Oaks-Moorpark Road	061110007	VEN	Deployed (Collocated)			

[7] The South Coast AQMD is relocating the Anaheim-Harbor Blvd site to a new site in the Anaheim area.

[8] The speciation network in the South Coast AQMD will include two types of filter-based speciation samplers, PTEP samplers and SASS samplers. Two sites, Los Angeles-North Main Street and Riverside-Rubidoux, will operate PTEP and SASS samplers in parallel.

[9] The South Coast AQMD plans to move the $PM_{2.5}$ FRM sampler from the North Long Beach site to a new site in the South Long Beach area, because special particulate studies conducted recently indicate that area better represents the expected maximum concentrations experienced in the greater Long Beach area.

Appendix B (continued)
Existing and Planned $PM_{2.5}$ Monitoring Network in California

***Key to Operating Agency Codes:**

ARB	Air Resources Board
BA	Bay Area Air Quality Management District
GBV	Great Basin Valleys Unified Air Pollution Control District
IMP	Imperial County Air Pollution Control District
IMPROVE	IMPROVE Steering Committee
KER	Kern County Air Pollution Control District
LAK	Lake County Air Quality Management District
MBU	Monterey Bay Unified Air Pollution Control District
MD	Mojave Desert Air Quality Management District
MEN	Mendocino County Air Quality Management District
NCU	North Coast Unified Air Quality Management District
NSI	Northern Sierra Air Quality Management District
SAC	Sacramento Metropolitan Air Quality Management District
SC	South Coast Air Quality Management District
SD	San Diego County Air Pollution Control District
SHA	Shasta County Air Quality Management District
SIS	Siskiyou County Air Pollution Control District
SJV	San Joaquin Valley Unified Air Pollution Control District
SLO	San Luis Obispo County Air Pollution Control District
VEN	Ventura County Air Pollution Control District
YS	Yolo-Solano County Air Quality Management District

APPENDIX C

SUMMARY OF $PM_{2.5}$ MASS DATA COLLECTED WITH FEDERAL REFERENCE METHOD SAMPLERS

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Appendix C
Summary of $PM_{2.5}$ Mass Data Collected with Federal Reference Method Samplers
Based on AIRS Extraction Dated: 08/09/01

Monitoring Planning Area / Site Name (AIRS Site ID)	Year	High 24-Hour Concentration mg/m³	*Average of Quarters mg/m³	*Valid?	†Number of Months	†Number of Quarters	‡Number of Observations
Bay Area AQMD							
Concord-2975 Treat Blvd (060130002)							
	1999	56.6	12.0	No	10	4	110
	2000	52.6	10.9	Yes	12	4	191
Fremont-Chapel Way (060011001)							
	1999	56.5	13.9	No	12	4	76
	2000	44.8	10.6	Yes	12	4	89
Livermore-793 Rincon Avenue (060010007)							
	1999	63.1	28.0	No	1	1	9
	2000	56.4	11.2	Yes	12	4	86
Redwood City (060811001)							
	1999	59.7	12.1	No	11	4	68
	2000	44.0	10.9	Yes	12	4	82
San Francisco-Arkansas Street (060750005)							
	1999	71.2	12.6	No	11	4	121
	2000	47.9	11.4	No	12	4	193
San Jose-4th Street (060850004)							
	1999	70.0	12.3	No	10	4	117
	2000	64.2	13.6	Yes	12	4	180
San Jose-Tully Road (060852003)							
	1999	77.0	14.5	No	10	4	117
	2000	67.2	12.2	No	12	4	188
Santa Rosa-5th Street (060970003)							
	1999	54.9	12.1	No	12	4	69
	2000	40.1	10.3	Yes	12	4	91
Vallejo-304 Tuolumne Street (060950004)							
	1999	90.5	14.1	No	10	4	63
	2000	60.1	11.6	Yes	12	4	90
Coachella Valley							
Indio-Jackson Street (060652002)							
	1999	29.6	12.8	No	10	4	83
	2000	28.6	11.2	Yes	12	4	115
Palm Springs-Fire Station (060655001)							
	2000	28.5	9.6	Yes	12	4	120
Great Basin Unified APCD							
Keeler-Cerro Gordo Road (060271003)							
	1999	40.7	7.2	No	10	4	69
	2000	68.0	9.6	No	8	3	72
Mammoth Lakes-Gateway HC (060510001)							
	2000	31.0	18.0	No	2	1	13

Appendix C (continued)
Summary of $PM_{2.5}$ Mass Data Collected with Federal Reference Method Samplers
Based on AIRS Extraction Dated: 08/09/01

Monitoring Planning Area / Site Name (AIRS Site ID)	Year	High 24-Hour Concentration µg/m³	*Average of Quarters µg/m³	*Valid?	†Number of Months	†Number of Quarters	‡Number of Observations
Imperial County APCD							
Brawley-Main Street (060250003)							
	1999	44.2	11.2	No	8	4	65
	2000	55.4	12.3	No	11	4	76
Calexico-Ethel Street (060250005)							
	1999	51.6	15.2	Yes	12	4	106
	2000	84.2	16.9	Yes	12	4	113
El Centro-9th Street (060251003)							
	1999	52.5	11.7	No	12	4	103
	2000	55.6	10.4	No	10	4	86
Lake County Air Basin							
Lakeport-Lakeport Blvd (060333001)							
	1999	14.5	4.4	No	12	4	47
	2000	9.4	4.2	Yes	12	4	58
Lake Tahoe Air Basin							
Echo Summit (060170012)							
	2000	10.0	3.8	Yes	12	4	122
South Lake Tahoe-Sandy Way (060170011)							
	1999	21.0	8.3	Yes	12	4	59
	2000	23.0	7.8	Yes	12	4	59
Mojave Desert Air Basin							
Lancaster-W Pondera Street (060379002)							
	1999	47.6	11.2	Yes	12	4	113
	2000	36.0	10.5	Yes	12	4	113
Mojave-923 Poole Street (060290011)							
	1999	27.6	8.5	No	11	4	99
	2000	28.7	7.5	No	12	4	74
Ridgecrest-Las Flores Avenue (060290012)							
	1999	22.9	8.5	No	7	3	48
	2000	38.6	7.8	No	12	4	91
Victorville-Armagosa Road (060710014)							
	1999	25.4	11.9	Yes	12	4	114
Victorville-14306 Park Avenue (060710306)							
	2000	31.0	11.9	No	12	4	115
Monterey Bay Unified APCD							
Salinas #3 (060531003)							
	2000	26.4	7.9	No	12	4	73
Salinas-Natividad Road #2 (060531002)							
	1999	30.8	9.8	No	11	4	102
Santa Cruz-2544 Soquel Avenue (060870007)							
	1999	31.4	9.4	No	11	4	89
	2000	23.3	7.9	No	12	4	72

Appendix C (continued)
Summary of $PM_{2.5}$ Mass Data Collected with Federal Reference Method Samplers
Based on AIRS Extraction Dated: 08/09/01

Monitoring Planning Area / Site Name (AIRS Site ID)	Year	High 24-Hour Concentration mg/m³	*Average of Quarters mg/m³	*Valid?	†Number of Months	†Number of Quarters	‡Number of Observations
Mountain Counties Air Basin							
Grass Valley-Litton Building (060570005)							
	1999	31.0	7.6	No	12	4	52
	2000	27.0	6.2	No	12	4	45
Portola-161 Nevada Street (060631009)							
	2000	46.0	10.6	No	8	3	67
Portola-Commercial Street (060631008)							
	1999	70.0	11.7	No	7	3	46
Quincy-N Church Street (060631006)							
	1999	92.0	13.3	No	10	4	73
	2000	37.0	9.4	No	12	4	104
San Andreas-Gold Strike Road (060090001)							
	1999	33.0	11.1	Yes	12	4	59
	2000	48.0	9.0	Yes	12	4	63
Truckee-Fire Station (060571001)							
	1999	50.0	9.0	No	8	4	46
	2000	23.0	8.8	Yes	12	4	111
North Coast Air Basin							
Eureka-Health Dept 6th and I Street (060231002)							
	1999	36.9	9.1	Yes	12	4	59
	2000	24.0	9.1	Yes	12	4	58
Ukiah-County Library (060450006)							
	1999	35.6	8.9	Yes	12	4	58
	2000	20.0	7.2	No	12	4	57
Northeast Plateau Air Basin							
Alturas-W 4th Street (060490001)							
	1999	40.0	7.9	Yes	12	4	56
	2000	38.0	8.5	Yes	12	4	58
Sacramento Valley Air Basin							
Chico-Manzanita Avenue (060070002)							
	1999	73.0	17.5	Yes	12	4	59
	2000	98.0	15.8	Yes	12	4	61
Colusa-Sunrise Blvd (060111002)							
	1999	55.0	13.2	No	12	4	85
	2000	28.0	8.0	Yes	12	4	114
Redding-Health Dept Roof (060890004)							
	1999	57.0	12.9	Yes	12	4	57
	2000	45.0	9.2	No	12	4	55

Appendix C (continued)
Summary of $PM_{2.5}$ Mass Data Collected with Federal Reference Method Samplers
Based on AIRS Extraction Dated: 08/09/01

Monitoring Planning Area / Site Name (AIRS Site ID)	Year	High 24-Hour Concentration mg/m³	*Average of Quarters mg/m³	*Valid?	†Number of Months	†Number of Quarters	‡Number of Observations
Sacramento Valley Air Basin (continued)							
Roseville-N Sunrise Blvd (060610006)							
	1999	79.0	13.4	Yes	12	4	59
	2000	51.0	12.2	Yes	12	4	59
Sacramento-Del Paso Manor (060670006)							
	1999	86.0[1]	23.7	No	7	3	66
	2000	81.0[1]	11.3[1]	No	9[1]	3[1]	38[1]
Sacramento-Health Dept Stockton Blvd (060674001)							
	1999	86.0	16.2	Yes	11	4	158
	2000	65.0	10.3	No	8	3	128
Sacramento-T Street (060670010)							
	1999	108.0	17.0	Yes	12	4	264
	2000	67.0	12.3	Yes	12	4	331
Woodland-Gibson Road (061131003)							
	1999	70.0	16.3	Yes	11	4	98
	2000	46.0	10.3	Yes	12	4	116
Yuba City-Almond Street (061010003)							
	1999	58.0[2]	15.9[2]	Yes[2]	12[2]	4[2]	58[2]
	2000	44.0[2]	11.2[2]	Yes[2]	12[2]	4[2]	60[2]
San Diego County APCD							
Chula Vista (060730001)							
	1999	47.1	15.1	Yes	12	4	103
	2000	40.5	13.1	Yes	12	4	101
El Cajon-Redwood Avenue (060730003)							
	1999	47.0	16.4	Yes	12	4	321
	2000	65.5	15.7	Yes	12	4	292
Escondido-E Valley Parkway (060731002)							
	1999	64.3	18.0	Yes	12	4	255
	2000	65.9	15.8	Yes	12	4	305
San Diego-12th Avenue (060731007)							
	1999	46.9	17.7	Yes	12	4	289
	2000	66.3	15.6	Yes	12	4	273
San Diego-Overland Avenue (060730006)							
	1999	43.4	14.1	No	12	4	85
	2000	48.5	12.4	Yes	12	4	101

[1] All of the yearly statistics for 2000 and the high concentration for 1999 are from the Sacramento-Del Paso Manor collocated monitor.

[2] The yearly statistics for 1999 and 2000, except the high concentration for 2000, are from the Yuba City-Almond Street collocated monitor. In 1999, the primary monitor's data were incomplete and in 2000 the data were complete, but the concentrations and the number of observations were lower for the primary monitor than for the collocated monitor.

Appendix C (continued)
Summary of $PM_{2.5}$ Mass Data Collected with Federal Reference Method Samplers
Based on AIRS Extraction Dated: 08/09/01

Monitoring Planning Area / Site Name (AIRS Site ID)	Year	High 24-Hour Concentration mg/m³	*Average of Quarters mg/m³	*Valid?	†Number of Months	†Number of Quarters	‡Number of Observations
San Joaquin Valley Unified APCD							
Bakersfield-5558 California Avenue (060290014)							
	1999	134.8[3]	31.2[3]	Yes	12	4	294[3]
	2000	112.7	23.0[4]	Yes	12	4	329
Bakersfield-1120 Golden State Highway (060290010)							
	1999	133.9	26.2	Yes	12	4	84
	2000	108.1	22.6	Yes	12	4	91
Bakersfield-410 E Planz Road (060290016)							
	2000	91.0	20.3	Yes	11	4	102
Clovis-N Villa Avenue (060195001)							
	1999	97.7	19.8	Yes	12	4	82
	2000	75.1	16.3	Yes	12	4	70
Corcoran-Patterson Avenue (060310004)							
	1999	53.1	14.3	No	8	3	44
	2000	76.0	16.4	Yes	11	4	67
Fresno-1st Street (060190008)							
	1999	136.0	27.7	Yes	12	4	275
	2000	160.0	25.5	No	9	4	194
Fresno-Pacific College (060195025)							
	2000	83.5	18.4	Yes	12	4	77
Merced-M Street (060472510)							
	1999	108.7	22.6	No	9	3	53
	2000	86.1	17.3	Yes	12	4	88
Modesto-814 14th Street (060990005)							
	1999	108.0	24.9	Yes	12	4	117
	2000	77.0	18.7	Yes	12	4	122
Stockton-Hazelton Street (060771002)							
	1999	101.0	19.7	Yes	12	4	117
	2000	78.0	15.5	Yes	12	4	123
Visalia-N Church Street (061072002)							
	1999	123.0	27.6	Yes	12	4	117
	2000	105.0	23.9	Yes	12	4	115

[3] The high concentration and average of quarters are from the Bakersfield-5558 California Avenue collocated monitor and are based on complete data that include 79 observations. The high concentration and the average of quarters for the primary monitor was 134.1 and 26.8, respectively.

[4] The average of quarters is from the Bakersfield-5558 California Avenue collocated monitor and is based on complete data that include 53 observations. The average of quarters for the primary monitor was 20.6 in 2000.

Appendix C (continued)
Summary of $PM_{2.5}$ Mass Data Collected with Federal Reference Method Samplers

Monitoring Planning Area / Site Name (AIRS Site ID)	Year	High 24-Hour Concentration µg/m³	*Average of Quarters µg/m³	*Valid?	†Number of Months	†Number of Quarters	‡Number of Observations
San Luis Obispo County APCD							
Atascadero-Lewis Avenue (060798001)							
	1999	27.5[5]	9.6	Yes	12	4	57
	2000	52.7[5]	10.8[5]	Yes	12	4	58
San Luis Obispo-Marsh Street (060792002)							
	1999	20.0	8.2	Yes	12	4	54
	2000	28.2	8.3	No	12	4	55
Santa Barbara County APCD							
Santa Barbara-W Carillo Street (060830010)							
	1999	21.3	12.9	No	6	4	15
	2000	24.2	13.1	No	10	4	44
Santa Maria-Broadway (060831007)							
	1999	24.3	11.4	No	5	2	22
	2000	28.7	9.8	Yes	12	4	57
South Coast Air Basin							
Anaheim-Harbor Blvd (060590001)							
	1999	68.6	25.9	No	8	4	92
	2000	113.9	20.3	Yes	12	4	273
Azusa (060370002)							
	1999	81.3	25.0	Yes	12	4	144
	2000	92.5	20.2	Yes	12	4	333
Big Bear City-501 W Valley Blvd (060718001)							
	1999	32.1	10.3	Yes	11	4	97
	2000	29.0	10.2	No	12	4	59
Burbank-W Palm Avenue (060371002)							
	1999	79.4	22.9	Yes	12	4	106
	2000	84.4	21.2	No	9	4	70
Fontana-Arrow Highway (060712002)							
	1999	97.9	25.7	Yes	12	4	121
	2000	72.9	24.5	Yes	12	4	112
Los Angeles-North Main Street (060371103)							
	1999	69.3	23.0	Yes	12	4	136
	2000	87.8	21.9	Yes	12	4	334
Lynwood (060371301)							
	1999	67.7	24.3	Yes	12	4	110
	2000	82.1	23.0	Yes	12	4	121
Mission Viejo-26081 Via Pera (060592022)							
	1999	56.6	17.0	No	7	3	65
	2000	94.7	14.7	Yes	12	4	119

[5] High concentration for 1999 and 2000 and annual average for 2000 are from the Atascadero-Lewis Avenue collocated monitor. The high concentrations from the primary monitor were 27.2 in 1999 and 50.9 in 2000 and the annual average for 2000 was 10.3.

Appendix C (continued)
Summary of $PM_{2.5}$ Mass Data Collected with Federal Reference Method Samplers

Monitoring Planning Area / Site Name (AIRS Site ID)	Year	High 24-Hour Concentration $\mu g/m^3$	*Average of Quarters $\mu g/m^3$	*Valid?	†Number of Months	†Number of Quarters	‡Number of Observations
South Coast Air Basin (continued)							
North Long Beach (060374002)							
	1999	66.9	20.7	Yes	12	4	148
	2000	81.5	19.6	Yes	12	4	304
Ontario-1408 Francis Street (060710025)							
	1999	85.8	25.4	Yes	12	4	96
	2000	73.4	24.1	Yes	12	4	111
Pasadena-S Wilson Avenue (060372005)							
	1999	73.0	19.9	No	10	4	95
	2000	66.3	19.4	Yes	12	4	110
Pico Rivera (060371601)							
	1999	85.6	25.7	Yes	12	4	111
	2000	89.5	24.0	Yes	12	4	116
Reseda (060371201)							
	1999	79.0	17.3	Yes	10	4	71
	2000	67.5	18.0	Yes	12	4	108
Riverside-Magnolia (060651003)							
	1999	89.9	26.7	Yes	12	4	110
	2000	79.3	25.3	Yes	12	4	111
Riverside-Rubidoux (060658001)							
	1999	111.2	31.0	Yes	12	4	137
	2000	119.6	28.3	Yes	12	4	304
San Bernardino-4th Street (060719004)							
	1999	121.4	25.6	Yes	12	4	104
	2000	89.8	25.9	Yes	12	4	92
Ventura County APCD							
El Rio-Rio Mesa School #2 (061113001)							
	1999	36.7	12.2	No	12	4	92
	2000	45.7	13.0	No	12	4	106
Piru-Pacific Avenue (061110009)							
	2000	37.6	10.7	No	2	1	13
Simi Valley-Cochran Street (061112002)							
	1999	64.6	13.8	Yes	12	4	109
	2000	55.3	14.8	No	12	4	102
Thousand Oaks-Moorpark Road (061110007)							
	1999	53.2	11.8	Yes	12	4	110
	2000	53.7	13.3	No	12	4	103

* *Average of Quarters* and *Valid?* are calculated according to the methods specified in 40 CFR Part 50, Appendix N. Typically, a year is complete, and the *Average of Quarters* is therefore valid, if 75% or more of the expected measurements are available in each quarter. Under certain circumstances, however, an *Average of Quarters* can be deemed valid with fewer measurements (see 40 CFR Part 50, Appendix N for details).

† *Number of Months* and *Number of Quarters* are the number of months and number of quarters, respectively, that include at least one measurement.

‡ *Number of Observations* is the total number of 24-hour measurements collected at the site during the year.

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APPENDIX D

ACRONYMS

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Appendix D
Acronyms

ADAM	Aerometric Data Analysis and Management
AIRS	Aerometric Information Retrieval System
AQS	AIRS Air Quality Subsystem
APCD	Air Pollution Control District
APS	Aerodynamic Particle Sizer
AQMD	Air Quality Management District
AQMP	Air Quality Management Plan
ARB	Air Resources Board
BAM	Beta Attenuation Monitor
CADMP	California Acid Deposition Monitoring Program
CFR	Code of Federal Regulations
CRPAQS	California Regional PM_{10}/$PM_{2.5}$ Air Quality Study
DGM	Dry gas meter
EC	Elemental carbon
FRM	Federal Reference Method
IMPROVE	Interagency Monitoring of Protected Visual Environments
MFM	Mass flow meter
MPA	Monitoring Planning Area
NAMS	National Air Monitoring Station
OC	Organic carbon
OEHHA	California Office of Environmental Health Hazard Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PAMS	Photochemical Assessment Monitoring Station
PM	Particulate Matter
PM_{10}	Particulate Matter (0 to 10 microns aerodynamic diameter)
$PM_{2.5}$	Particulate Matter (0 to 2.5 microns aerodynamic diameter)
PTEP	Particulate Technical Enhancement Program
QAPP	Quality Assurance Project Plan
R&P	Rupprecht & Patashnick

Appendix D (continued)
Acronyms

RAAS	Reference Ambient Air Sampler
SASS	Spiral Aerosol Speciation Sampler
SCCAPM	Southern California Center for Airborne Particulate Matter
SCPMS	Southern California PM Supersite
SIP	State Implementation Plan
SLAMS	State and Local Air Monitoring Station
SMPS	Scanning Mobility Particle Sizer
SPM	Special Purpose Monitoring
SSI	Size-Selective Inlet
TEOM	Tapered Element Oscillating Microbalances
TEP	Technical Enhancement Program
U.S. EPA	United States Environmental Protection Agency
XRF	X-Ray Fluorescence

APPENDIX E

GLOSSARY

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Appendix E
Glossary

Aethelometer
An air monitoring instrument that generates hourly (and even every-five-minute) average measurements of black soot, which can be related to elemental carbon.

Air Basin
A land area with generally similar meteorological and geographic conditions throughout. To the extent possible, air basin boundaries are defined along political boundary lines and include both the source and receptor areas. California is currently divided into 15 air basins.

Air District
A political body responsible for managing air quality on a regional or county basis. California is currently divided into 35 air districts. (See also Air Pollution Control District and Air Quality Management District).

Air Monitoring
Sampling for and measuring of pollutants present in the atmosphere.

Air Pollutants
Amounts of foreign and/or natural substances occurring in the atmosphere that may result in adverse effects to humans, animals, vegetation, and/or materials.

Air Pollution Control District (APCD)
A county agency with authority to regulate stationary, indirect, and area sources of air pollution (e.g., power plants, highway construction, and housing developments) within a given county, and governed by a district air pollution control board composed of the elected county supervisors. (See also Air Quality Management District).

Air Quality Management District (AQMD)
A group of counties or portions of counties, or an individual county specified in law with authority to regulate stationary, indirect, and area sources of air pollution within the region and governed by a regional air pollution control board comprised mostly of elected officials from within the region. (See also Air Pollution Control District).

Air Quality Management Plan (AQMP)
A plan prepared by an APCD/AQMD, for a county or region designated as a nonattainment area, for the purpose of bringing the area into compliance with the requirements of the national and/or California ambient air quality standards. AQMPs are incorporated into the State Implementation Plan (SIP).

Ambient Air Quality Standards (AAQS)
Health- and welfare-based standards for outdoor air which identify the maximum acceptable average concentrations of air pollutants during a specified period of time. (See also California Ambient Air Quality Standard, National Ambient Air Quality Standard, and Criteria Air Pollutant.)

Appendix E (continued)
Glossary

Attainment Area
A geographical area identified to have air quality as good as, or better than, the national and/or California ambient air quality standards (NAAQS/ CAAQS). An area may be an attainment area for one pollutant and a nonattainment area for others.

California Air Resources Board (ARB)
The State's lead air quality agency consisting of an eleven-member board appointed by the Governor and several hundred employees. CARB is responsible for attainment and maintenance of the state and federal air quality standards, and is fully responsible for motor vehicle pollution control. It oversees county and regional air pollution management programs.

California Ambient Air Quality Standard (CAAQS)
A legal limit that specifies the maximum level and time of exposure in the outdoor air for a given air pollutant and which is protective of human health and public welfare (Health and Safety Code 39606b). CAAQSs are recommended by the California Office of Environmental Health Hazard Assessment and adopted into regulation by the CARB. CAAQSs are the standards which must be met per the requirements of the California Clean Air Act (CCAA).

Federal Reference Method (FRM)
Sample collection methods that, as determined by the U.S. EPA, produce measurements that can be used for comparison to the National Ambient Air Quality Standards. This term is often applied to sampling devices that the U.S. EPA has approved for use in comparison to a NAAQS, e.g., an FRM $PM_{2.5}$ sampler.

Fugitive Dust
Dust particles that are introduced into the air through certain activities such as soil cultivation, or vehicles operating on open fields or dirt roadways. A subset of fugitive emissions.

National Air Monitoring Stations (NAMS)
Monitoring sites that are part of a federal network that is intended to assess long-term trends.

National Ambient Air Quality Standards (NAAQS)
Standards established by the United States EPA that apply for outdoor air throughout the country. There are two types of NAAQS. Primary standards set limits to protect public health and secondary standards set limits to protect public welfare.

Nonattainment Area
A geographic area identified by the U.S. EPA and/or CARB as not meeting either the National Ambient Air Quality Standards or the California Ambient Air Quality Standards for a given pollutant.

Office of Environmental Health Hazard Assessment (OEHHA)
A department within the California Environmental Protection Agency that is responsible for evaluating chemicals for adverse health impacts and establishing safe exposure levels. OEHHA also assists in performing health risk assessments and developing risk assessment procedures for air quality management purposes.

Particulate Matter (PM)
Any material, except pure water, that exists in the solid or liquid state in the atmosphere. The size of particulate matter can vary from coarse, wind-blown dust particles to fine particle combustion products.

$PM_{2.5}$
A criteria air pollutant consisting of airborne particles with an aerodynamic diameter less than or equal to a nominal 2.5 microns. This fraction of particulate matter penetrates most deeply into the lungs. $PM_{2.5}$ also causes visibility reduction.

PM_{10}
A criteria air pollutant consisting of airborne particles with an aerodynamic diameter less than or equal to a nominal 10 microns (about 1/7 the diameter of a single human hair). Their small size allows them to make their way to the air sacs deep within the lungs where they may be deposited and result in adverse health effects. PM_{10} also causes visibility reduction.

Precursor
An airborne substance, such as volatile organic compounds, nitrogen oxides, or sulfur oxides, that can change or combine with other substances to form $PM_{2.5}$.

Regional Haze
The haze produced by a multitude of sources and activities which emit fine particles and their precursors across a broad geographic area. National regulations require states to develop plans to reduce the regional haze that impairs visibility in national parks and wilderness areas.

Secondary Particle
Particles that are formed in the atmosphere. Secondary particles are products of the chemical reactions between gases, such as nitrates, sulfur oxides, ammonia, and organic products.

Spiral Aerosol Speciation Sampler (SASS)
A type filter-based $PM_{2.5}$ speciation sampler that collects 24-hour integrated samples.

State Implementation Plan (SIP)
A plan prepared by states and submitted to U.S. EPA describing how each area will attain and maintain national ambient air quality standards. SIPs include the

technical foundation for understanding the air quality (e.g., emission inventories and air quality monitoring), control measures and strategies, and enforcement mechanisms.

State and Local Air Monitoring Stations (SLAMS)
Sites (which include NAMS sites as a subset) that collect data needed for developing an effective State Implementation Plan (SIP).